CHANGING ANIMAL UTILIZATION PATTERNS AND THEIR IMPLICATIONS: SOUTHWEST ECUADOR (6500 B.C.-A.D. 1400)

BY

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The purpose of this study is to determine subsistence practices and related human behavioral patterns for Valdivia Phase (3000 B.C.-1500 B.C.) inhabitants of southwest Ecuador. This goal is accomplished by an analysis of vertebrate, faunal remains and the application of cultural, ecological research methods. A total of fifteen samples is considered, including three pre-Valdivia, eight Valdivia, and four post-Valdivia sites (6500 B.C.-A.D. 1400). For most of these sites faunal lists with minimum numbers of individuals, number of bone fragments and bone weights are included. In addition, biomass, edible meat, calories, and protein estimates are computed for the principal sites. Based on these analyses, questions concerning protein scarcity and protein acquisition, changes in protein exploitation and subsistence orientation, hunting and fishing methods, and human behavioral patterns for the various groups are considered.

CHAPTER I
INTRODUCTION

Whatever is one's theoretical viewpoint, few anthropologists today would argue against a particular stage in cultural development in which one or more cultural groups shifted from a hunting-gathering sybsistence system to a sedentary one based on agriculture. This change in subsistence emphasis is an important shift because it laid the foundations for later cultural evolution. With the domestication of plants and an increasing reliance on cultigens, people become more sedentary, populations increased, more complex social, political, and economic systems developed and in some areas urban centers and civilizations arose. In the New World this initial shift from a hunting-gathering economy to a sedentary agricultural one is referred to as the Formative Stage.

The exact definition of the Formative Stage and those traits that are most diagnostic of it are the subjects of some debate. Gordon R. Willey and Philip Phillips (1958:144) stress the presence of maize and/or manioc agriculture and "... the successful socioeconomic integration of such an agriculture into well-established sedentary village life" in their definition of the Formative. James A. Ford indicates several possible oversimplifications in Willey and Phillip's definition and offers a definition based more on certain artifact types. Ford (1969:5) views the Formative

> ... as the 3000 years (or less in some regions) during which the elements of ceramics, ground stone tools, handmade figurines, and manioc and maize agriculture were being diffused and welded in the region extending from Peru to the eastern United States.

Whichever position is held, the salient points in each appear to be the incorporation of agriculture and sedentism and their related cultural characteristics into a new way of life. This new form sets the stage for subsequent cultural evolution.

One of the earliest manifestations of the Formative Stage is the Valdivia Phase of coastal Ecuador. This phase has received considerable study in the last 25 years (Bischof and Gamboa 1972; Bushnell 1951; Estrada 1956 and 1961; Hill 1966; Lanning 1976a; Lathrap and Marcos 1975; Meggers, Evans, and Estrada 1965; Norton 1971; Paulsen 1971; Porras 1973; Stothert 1974; Zevallos Menendez 1970; Zevallos Menendez and Holm 1960). For the most part, these studies have addressed themselves to the establishment of the ceramic chronologies and they provide basic site information as well as development of hypotheses concerning the origins of the Formative of this region. Recently there has been a growing interest in obtaining evidence of agriculture from these sites. This line of research has met with some success (Zevallos Menendez 1970) even though most plant remains--and thus direct evidence of agriculture--are not well preserved in sites of this region.

With few exceptions (Sarma 1974; Meggers, Evans, and Estrada 1965) little attention has been paid to the non-agricultural segment of subsistence. The relatively high survival rate of animal bone provides ample opportunities to study at least this aspect of the quest for food. Detailed analysis of food bone refuse can provide information not only on past dietary patterns, but also on the technology used to obtain the

animals. When bone analysis is coupled with human, ecological, research methods, additional information on subsistence related, human behavioral patterns may be revealed. This study attempts to arrive at a better understanding of some Formative patterns through the analysis of the vertebrate remains associated with eight Early Formative (Valdivia) sites in Guayas Province, Ecuador. To understand subsistence patterns prior to the Early Formative, the vertebrate remains from three pre-Valdivia sites are analyzed. Post-Valdivia developments are indicated by the remains from four additional sites (Fig. 1).

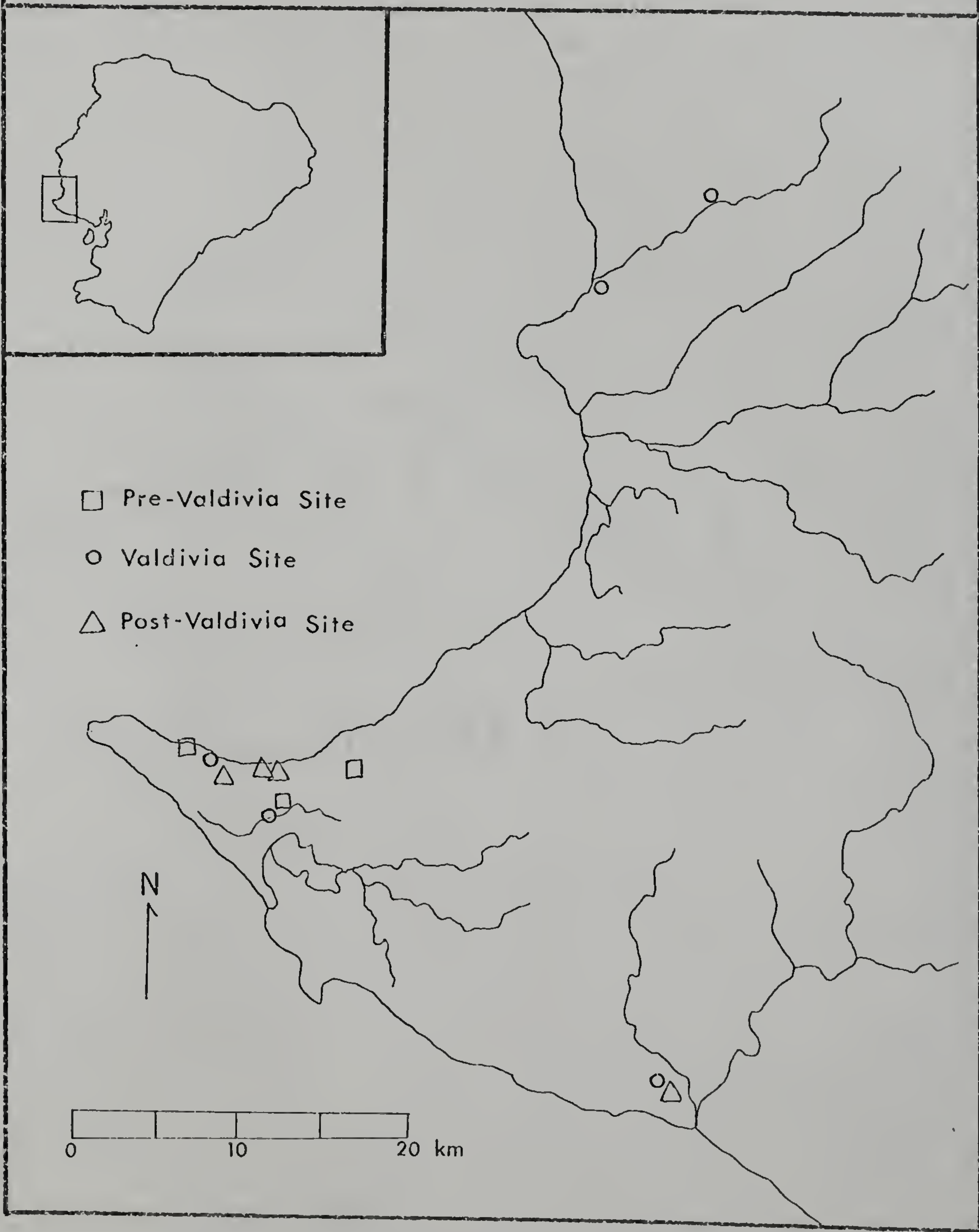
To achieve the aim of this study, i.e. to analyze the subsistence practices and related human behavioral patterns of the Formative Valdivia culture of the area, a modification of Julian H. Steward's (1955) cultural ecological procedures is applied to the archaeological material. The natural environment of the area and technology used to exploit the food resources are examined.

Environments are not static, but are subject to change. Some environmental areas are relatively stable while others, due to their location at the edge of two different and unstable climatic zones, are particularly susceptible to environmental fluctuation. In all areas changes in the climatic conditions can profoundly affect their animal populations. Therefore, before any real understanding of resource use within an area can be achieved, some attempt to reconstruct previous environmental conditions is necessary.

Two lines of evidence can be used in attempting to determine the technology employed to obtain the animals. First, the artifactual remains themselves can be considered. Secondly, the animals found in the midden can be analyzed and, by using ecological and ethnological studies,

Fig. 1

SITE LOCATIONS WITHIN THE STUDY AREA



the hunting and fishing methods effective in catching these animals suggested. Coupling the environmental reconstruction with an analysis of subsistence-related technology indicates which of the available resources were used and how the people might have obtained them.

Having reconstructed the enviornment and the subsistence technology of the culture, the second step of Steward's procedure can be attempted. In this step, the human behavioral patterns connected with particular technologies that are effective in catching certain animals are examined. One method of viewing this is by utilizing game theory.

Game theory studies on ethnographic populations (Davenport 1971; Gould 1972) have revealed people's attempt to maximize returns while minimizing the time, the energy, and the risk involved in obtaining them. On any given day the subsistence strategies adopted take into account the amount of time and energy that will be expended in attempting to achieve a certain economic goal. For example, will it take more time and energy to track, kill, butcher, and carry back to camp a large mammal or will more of the desired food be obtained and less time and energe expended by spending the day fishing? Is the risk of not obtaining food greater if the person hunts or if he or she fishes? Will more proteins and calories be obtained by hunting or by fishing? The abundance, ease of capture and nutritional and energy values of the various resources will determine which strategies or combination of strategies are most effective in obtaining the needed foods. Rodents might be abundant and by using traps they may be easy to capture, but they are small in size and provide little meat. Deer are less abundant, harder to capture, but for each successful hunt a greater volume of meat is obtained. Fish might be very abundant and easy to capture, but are

relatively small, and when compared with mammals, have a low caloric and protein content. The strategy chosen by a people on a particular day takes these factors into consideration.

Subsistence strategies are closely related to the human behavior patterns of a people. Some procurement techniques require relatively large numbers of people, while others are more successful if carried out individually. For example, in the South American tropical forest where species densities are low, the maximum terrestrial hunting returns for a population, as a whole, occur if the hunters, individually or in groups of two or three, exploit several different areas. Using this method the hunters maximize the possibilities that at least one of the areas hunted will provide some game.

In areas with large gregarious herds, as in the North American Great Plains, communal hunting provided maximum returns for the time and energy expended. In this region individual hunters could kill only a relatively few animals before the herd scattered. If, on the other hand, a communal drive and jump is practiced, a larger number of animals can be obtained. The same principle is applicable to fishing. Netting and poisoning of waters, in which large densities of fishes occur, result in greater returns if a number of people cooperate in the operation. Hook and line fishing, because of the relatively low densities of carnivorous fishes, provides greater return if the fishermen distribute themselves individually or in small groups over a wider area.

The third step in Steward's procedure involves determining the extent to which subsistence-related, human behavioral patterns effect other aspects of culture. There are many methods of studying this

relationship. One technique of reconstructing past cultural patterns is through ethnographic analogy. Ideally, by comparing archaeologically reconstructed exploitative patterns with a series of well research ethnographic samples, it would be possible to suggest certain subsistence-related, prehistoric cultural patterns. Unfortunately, good ecologically-oriented ethnographic studies of the subsistence patterns of a large series of groups, relying on different subsistence bases, have yet to be undertaken. Until this is done, detailed correlations between certain susbistence patterns and other aspects of a culture cannot be attempted. Nevertheless, some generalizations can be made. A comparison of two groups of people--one which relies primarily on aquatic fish resources, and the other which depends on terrestrial forms for their animal protein, suggests some of these general correlations.

Yolanda Murphy and Robert F. Murphy (1974) have worked among two groups of Mundurucu Indians in Brazil, one savanna dwellers and the other riverbank inhabitants. Both groups rely primarily on slash and burn agriculture for their caloric and carbohydrate needs. Although the savanna group fish, most of their animal food comes from hunting. Both individual and communal hunting are practiced. Yields obtained by individual hunters vary and when a large animal is caught the Mundurucu share it with other families in the village. One of the central focuses of the savanna Mundurucu is the men's house and all its social roles, duties, and functions. Murphy and Murphy (1974:228) believe that "... the need for cooperation in hunting utilizes general human fears is shaping the institution of the men's house."

The other Mundurucu group moved to the rivers primarily to exploit the rubber trees. Here they rely on aquatic protein resources,

principally fishes. These Mundurucu do not share animal protein.

> The very nature of fishing--the individuality of the activity, the ease of the catch, the time available and necessary, the size of the fish itself--all militate against collectivization of the catch. And, hunting, does little to promote broader social cohesion (Murphy and Murphy 1974: 190-191).

If the presence of institutions like mens' houses are causally related to hunting conditions, i.e. low species density, high individual risk, and large animal size and rapid spoilage, then, all other factors being equal, groups living under these same conditions would be expected to have similar functionally related institutions. In addition, certain redistribution channels would be anticipated. On the other hand, in groups experiencing none of these pressures, i.e. fishing groups, an institution of the men's house type would not be expected to occur, nor would the same form of redistribution channels appear.

Elaborate and time consuming procurement or food production methods also suggest certain social elements. Specialization requires an exchange of materials in which the specialists are able to trade their goods for those that they are not able to obtain directly through their own efforts. This leads to the development of exchange systems and their social and cultural ramifications.

In recent years, anthropologists have become concerned with various points that Steward did not treat, points that are revelent to the present study (Vayda and Rappaport 1968). Particularly important among these is the ecological dimension of human populations. Human beings do not live separated from all other living things, but are an active component in the ecosystem and, as such, their very presence alters it. People both effect and are affected by changes in the ecology of an

area. In subsistence-related terms, climatic changes can radically modify the types and abundances of food availability. Agricultural crops that are grown on marginally productive lands are particularly susceptible to unusual freezes, droughts, or floods. But hunting, fishing, and agricultural techniques also can alter an area. The plot clearing and periodic shifts in gardens practiced by slash and burn agriculturalists contribute to the modification of the environment. The techniques involved in slash and burn agriculture result in increasing forest-edge conditions and therefore, species that prefer this type of habitat. At the same time, the area available for species that favor deep, undistrubed forests is decreased. Fish poisoning of ponds and activities such as fire drives are other examples of ecological modifications by human populations.

Recent human ecological studies (Harris 1966; Rappaport 1968) have supported Steward's basic assumption, i.e. that there exists a causal relationship between basic subsistence strategies and other aspects of culture. A successful subsistence strategy is mandatory of a people are to survive. The particular set of strategies adopted appear to be causally related to other aspects of a culture.

The remainder of this study applies these cultural, ecological methods of analysis to the vertebrate-related, subsisteuce strategies of the Valdivia Culture, and Early Formative manifestation of coastal Ecuador. The study attempts to derive information on certain animal-related, subsistence techniques and the corresponding human behavioral patterns and to determine how and why these techniques and patterns changed through time.

CHAPTER II
NUTRITIONAL NEEDS AND CALORIC REQUIREMENTS

In any complete study of people and their relationship to their environment, simply listing the resources utilized does not provide an adequate description of the importance of the various foods in the diet. Whether a people relied primarily on cooperative net fishing or on solitary hunting or some combination of these strategies, the relative importance of the animals and of the methods adopted to obtain them greatly effects subsistence-related, cultural manifestations. Therefore, in studying subsistence systems some idea of the relative quantity and quality of the various foods in the diet of the people, and of the strategies employed to acquire these foods, is needed. This necessitates consideration of both nutritional requirements and caloric needs.

Without the right (in the nutritional sense) kinds of foods, a people will cease to function and die. Humans have learned, probably through trial and error, that the combinations of certain foods and the adoption of certain methods of obtaining such enabled them to be healthy and to reproduce. The foods eaten by a people and the methods or strategies adopted to obtain these foods differ greatly from area to area, but to remain healthy all populations must fulfill their basic nutritional needs.

With respect to human growth and metabolism, food serves two basic purposes. It provides the structural material used in growth and maintenance of the body and it furnishes the energy that is needed in

metabolism. The first of these is referred to as the quality of the food, i.e. the foods' chemical ingredients; the second as the quantity of the food, i.e. its energy content (Sebrell and Haggerty 1967).

For proper growth and development certain elements and compounds must be available to an organism from its food supply. Humans need the organic compounds of carbohydrates, fats, proteins, and vitamins and certain inorgainc minerals.

Carbohydrates, composed of the elements carbon, hydrogen, and oxygen, vary in complexity from simple three-carbon sugars to complex polymers (Pike and Brown 1967). Carbohydrates are divided into simple compounds, the monosaccharides and disaccharides of the sugars, and complex compounds, the polysaccharides of cellulose and starches (Arlin 1972). Since the human digestive system is only able to digest a limited amount of cellulose and most is passed out of the body largely unchanged, cellulose is largely unimportant in human nutrition. The polysaccharide plant starches provide the principal energy source for most human populations. So important, in fact, that peoples are often categorized according to their starch food, e.g. rice growers or maize horticulturalists (Arlin 1972).

Lipids (or fats) are made up primarily of carbon and hydrogen. The triglycerides, compounds of glycerol and three fatty acids, are important in terms of nutrition. It is in these forms that energy is stored by animals and, to a lesser extent by plants (Arlin 1972). Certain lipids furnish an energy source for cells, others function as structural compounds, and still others as hormones (Pike and Brown 1967).

Proteins are composed of the basic organic elements carbon, hydrogen, and oxygen, but in addition also contain nitrogen and sulfur.

The basic structural units of proteins are the amino acids. The amino acids contain an amino group ($-NH_2$) and an acid group and have side chains which are responsible for the various chemical properties of the acids (Arlin 1972). Although there are only about 20 amino acids, the combination of amino acids present in any particular compound, its position in the molecule, and the spatial arrangement of the molecules, result in thousands of different kinds of proteins (Pike and Brown 1967). All foods contain some protein, but both the amount present and the proportion of the various amino acids vary from one protein source to another. In human nutrition, protein foods are required in order for the body to obtain the amino acids necessary for its own protein synthesis which, in turn, is needed for growth and maintenance. Only when all the necessary amino acids are available will the synthesis of a particular protein occur. The lack of one of the needed amino acids will result in the termination of the construction of that particular protein. The human body can manufacture most of the amino acids if enough nitrogen is present, but since the only available source of nitrogen is protein, protein is therefore a necessary food constituent. In addition, there are eight amino acids, the essential amino acids, that cannot be synthesized. These must be supplied in the diet if normal protein manufacture is to occur (Arlin 1972).

The other two classes of nutrients necessary for humans are vitamins and minerals. The human body requires vitamins in trace amounts for health and growth. Vitamins are all organic chemicals, but are otherwise unrelated. Some vitamins cannot be synthesized in adequate amounts by cells and must be ingested. Minerals, inorganic chemicals, are also essential in small quantities for normal body development

(Arlin 1972). Of the 16 essential mineral elements, calcium, phosphorus, sodium, iron and potassium are required in greatest quantities.

In addition to furnishing the building material for the body, food also provides the energy that is needed in metabolism. This energy requirement is measured in kilogram calories (Kcals. or Cals.) and is defined as the amount of heat required to elevate the temperature of one kilogram of water one degree centigrade. When oxidized within the cell, one gram of protein provides four calories; one gram of carbohydrates four calories; and one gram of fat nine calories.

In general, plants manufacture carbohydrates, store excess energy as starch, and rely on cellulose for structure. Animals store energy as fat, synthesize very little carbohydrates and often depend on a calcareous skeleton for support. They also require large amounts of protein in the form of muscles for locomotion (Arlin 1972). These muscles consist primarily of protein and fat with a high proportion of water. Meat also functions as a source of vitamins and minerals.

With the exceptions of milk and liver, only plants provide carbohydrates. Animal sources of foods are usually high in fats since animals store their energy in this form. The actual amounts of fat vary according to the organism and its condition. Poultry, for example, provides less fat by weight than beef. Most species of fish are also relatively low in fats. Certain invertebrates, e.g. oysters, crabs, shrimp, clams, and lobster, are essentially fat-free. Fats occur in significant amounts in plant foods only in seeds, nuts and fruits (Arlin 1972). Protein occurs in all foods whatever their origins. Some protein foods, however, have a higher quality or biological value based on the efficiency in which their proteins are digested and absorbed, and the

proportions in which the essential amino acids are present. Although animal protein is both more abundant per unit weight (e.g. per 100 grams) and has a higher quality or biological value than almost all plant protein, 30% of the world's protein comes from cereal grains and 40% from other plant sources. Since cereal grains are structured to provide a complete food source for the sprouting plants, they contain starch, protein, vitamins and minerals needed for growth of the plant. The primary purpose of tubers and roots, on the other hand, is to store energy and they do this in their starchy underground structures. This is an important distinction when comparing the relative value of these two food sources (e.g. wheat is about 12% protein, rice 8% and the potatoes and manioc contain only 2% or less (Arlin 1972).

With respect to protein, nutritional needs can be met in three ways. First, a person can consume large amounts of food. This is the method adopted by many rice-eating peoples. By consuming up to one pound of raw rice per day a person can obtain 30 to 35 grams of protein. In addition, rice is fairly adequate with respect to amino acids. Maize, on the other hand, is so deficient in some essential amino acids that no matter what volume is consumed it alone can never furnish the protein necessary for human growth and maintenance. Most types of maize lack the vitamin niacin and the amino acids lysine and tryptophan (Arlin 1972).

Another method for obtaining an adequate amount of protein and amino acids consists of adding a small amount of animal protein to the diet. A small amount of meat or fish added to rice, beans or corn will supplement the cereal protein to such a degree that "... it will adequately sustain an individual of small stature" (Arlin 1972:242).

The third method that can be used to meet minimum protein requirements involves the use of complementary vegetable proteins. For example, the amino acids in cereals and legumes supplement each other and together provide the essential amino acids needed. The presence of large populations in Latin America, who live principally on a corn-bean diet illustrates this third method.

Although three alternative methods of obtaining adequate proteins are theoretically possible, not all of these methods are possible alternatives for a given people living in a particular setting. Environmental or ecological factors, combined with the level of technological developments, favor the utilization of certain methods and preclude others. In most cases, the most efficient way to fulfill nutritional needs is through a combination of carbohydrate-rich plant foods and protein-rich animal sources with both animals and certain plant parts providing the fats needed.

Not all the nutritional and caloric parameters of a prehistoric diet can be quantified. Some dimensions are more amenable to this type of analysis than others. Methods are now being developed to ascertain the relative importance of plant and animal foods in the diet of prehistoric populations (Brown 1973). The analysis of trace elements in human bone provides the data base for this type of study. The techniques used in trace elemental analysis are still in the process of being refined and, unfortunately, could not be applied to the material from the sites considered in this study.

Data from the animal remains from archaeological middens are more readily available for a quantitative approach. The presumed nutritional value of these remains can be viewed in two principal ways: the degree

to which they furnish the necessary calories or energy units for human populations, and the degree to which they provide the required proteins.

An energetic or caloric view of an ecosystem furnishes the opportunity to see the system as a whole. Since energy functions as a common denominator for all trophic levels, a caloric approach to an ecosystem provides an opportunity to view the net gains and losses for each element of the entire system and is ideal for studying all parameters of the food web. This method has a wide range of application, including politics, economics, and religion (Odum 1971). Energy, however, is difficult to measure. Even for a numerically small segment of the system--human populations-many difficulties arise in attempting to obtain adequate caloric measurements. In addition, for a complete ecosystemic study, information on all trophic levels is needed. This approach is not suitable when remains from only one part of the food web is available. It is important, however, not to lose sight of this energetic aspect of subsistence and its ramifications.

Protein functions as one of the basic nutrients and as such can act as a limiting factor in population growth and culture development (Carneiro 1961; Gross 1975). Protein can be measured and is amenable to study based on zooarchaeological data. It, like the caloric approach, possesses some inherent drawbacks. Most studies on the importance of protein, have been carried out on United State populations under optimum conditions. The requirements of prehistoric peoples conceivably could have been different. Also, protein quality can deteriorate with cooking, but the rate is not constant. Considerable error could be introduced if the zooarchaeological remains are viewed as raw, baked, or boiled meat. The protein approach in analysing archaeological food bone does

furnish data on the relative importance of various foods utilized to provide this basic nutrient.

When calories and protein values of animals are considered together, certain differences appear. In some cases certain animals will provide proportionately more protein, but fewer calories, than another group of animals. When viewing archaeological food remains quantitatively, it should be remembered that calories and protein serve two, very different, functions in the body. Both are required.

CHAPTER III
METHODOLOGY

Since protein is an essential nutritional requirement for growth and development, its consumption and the methods used to obtain it are an important human activity. Therefore, a study of protein foods utilized provides significant data about a culture. To study this aspect of Formative cultural manifestations in southwestern Ecuador, bone refuse from eight sites of the Valdivia Phase is considered (Fig. 1). Four of these sites are located on the Santa Elena Peninsula (OGSE-174, OGSE-62, OGSE-62C, OGSE-42). Two other sites are situated farther north along the Valdivia River, one at its mouth (Valdivia) and the other about 15km upstream (Loma Alta). The seventh site, which because of its two cultural divisions is considered as two sites, is east of the Santa Elena Peninsula and five km. upstream from Chanduy on the Rio Verde (Real Alto). All sites are located in Guayas Province, Ecuador. These eight sites form the data base for the following reconstruction.

Seven additional sites are also treated here. These sites provide a longer time frame and are included to indicate changing exploitation patterns from pre-Valdivia through post-Valdivia times. Three of these sites are pre-Valdivia (OGSE-80, OGSE-38, OGSE-63) and four post-Valdivia (OGSE-46D, OGSE-46U, OGSE-41E, OGCH-20). Three are located on the Santa Elena Peninsula, with the fourth being eastward along the Rio Verde.

The faunal bone samples from most of these sites are small and, unless the field archaeologists indicated some anomaly, all the material from a site is treated as one unit. In two cases the excavations revealed heterogeneous distributions of artifactual materials. For this reason the Loma Alta sample is treated as two units, JII and JIII. The presence of wall-trenches, pits, and burials at Real Alto necessitated the analysis of this site in a number of discrete units.

Certain types of error are inherent in any method of analysis used. Although many of these errors can be minimized by careful processing of the materials, some sources of error remain. A cognizance of these possible sources of inaccuracy is necessary to avoid misinterpretation. In zooarchaeological analysis, the error sources can be divided into four types: initial deposition practices, post-depositional and pre-excavational factors, excavation techniques, and analytical inaccuracies.

The way a people butchered their meat, cooked and served the food and disposed of the refuse all effect the bone remains found in the site. The practice of butchering in specialized areas or butchering large animals at the kill site and returning to camp only parts of the carcass, bias the sample. The location of the test pits in butchering areas can result in a very different faunal reconstruction than the analysis of other refuse materials. Food preparation techniques can also affect the bone remains. Long periods of roasting or boiling of entire carcasses or joints of meat can weaken the structure of the organic constituents of the bone and decrease its survival time (Chaplin 1971). Also dietary practices such as consuming small animals whole, e.g. sardines or anchovies, or the grinding of the bone into meal may eliminate material from analysis. The disposal of the bone after consumption can result in a further uneven distribution of the material. Large bones may have

been eliminated from the refuse areas by their use as raw materials in the manufacture of utilitarian, ritual, or decorative objects.

Secondly, even after deposition, the bones are still susceptible to destruction through the activity of rodents and carnivores and by weathering factors and soil conditions. The overall effect of these various factors and conditions vary from modifying the faunal composition of the sample radically to causing very little change in the midden bones.

The third source of error, a controllable one, concerns the recovery techniques. All too often excavators keep only certain bones, or, if they use a screen, use one with so large a mesh size that it results in the loss of many otherwise recoverable bones. These small, seemingly insignificant bones often supply very detailed climatic information, and through analysis of habit and habitat of the species represented, may provide informative data on procurement patterns and practices.

Finally, once back in the lab the level of identification depends on the comparative material available for consultation. Especially in areas where the taxonomy of the animals concerned has not been fully refined, this level of analysis can result in inaccurate identification. Without adequate comparative materials many otherwise identifiable bones can only be assigned to relatively high taxons, such as orders or families. This is unfortunate, since identification to species level for animals whose habits and habitats are well known can provide detailed information on various aspects of a people's exploitative methods.

In addition to identification, the analytical methods used can result in erroneous reconstructions. Especially susceptible to error are the methods used to determine the relative numbers and importance of the species represented in the sample. Three methods are widely used

in the determination of the relative numbers of species and their importance in the diet (Chaplin 1971); the minimum number of individuals (MNI) method, the fragment method, and the weight method. All three methods contain some inherent problems, but, for a number of reasons, the MNI method is used here (Appendix A). This method simply tabulates for each total sample the most often recurring bone of a species, i.e. four, distal, right humerii of deer represent four deer. Nevertheless, the number of fragments and the weights represented by the various species in all the samples, except Valdivia, are tabulated in the Appendix. These are included to provide the data needed for those wishing to use a different method. The bone from the Valdivia site is mineralized and for this reason was not weighed.

Once the MNI is determined, the biomass, the total live weight represented by each species, genus, family or order, is calculated for each of the seven principal sites (Appendix B). Samples from the other sites were either too small or the nature of the samples such that biomass estimates would be misleading.

Several methods have been developed to estimate the size of animals represented by the archaeological remains (White 1953; Reed 1963; Casteel 1974; Smith 1975; Wing 1976a). Each method has its limitations (Wing 1976a), but because Casteel's method appears to be the most accurate for the types of animals considered here it was used. Casteel's method is based on the relationship between skeletal weight or certain bone measurements of an animal to the animal's live weight. By weighing the skeletons of a series of animals of known live weight or measuring a certain skeletal element, it became possible to generate least square regression curves. These curves utilize the formula

$$\log y = m(\log x) + b$$

where: y=live weight
m=slope of the line
x=skeletal weight
b=y-intercept of the log-log plot

and indicate the reliability or the correlation coefficient (r) of the estimate.

To generate the formulae employed in this study, live weights and skeletal weights from specimens at the Florida State Museum were used. Least square regression curves were computed using skeletal weight and live weights for mammals, birds, turtles, catfish, and perciform fishes and on cervical centrum width on the perciform fishes and the largest centrum width on the sharks and snakes. These formulas are listed in Appendix C. It should be noted that the number of specimens used in the calculations of these curves in some cases are very small. For this reason considerable error could be introduced into the live weight estimates.

Because of the variability in the types of zooarchaeological remains it was necessary to use different methods to arrive at live weight estimates for different animals. The first method, the one that is probably most accurate, uses the centrum width measurement and the relevant formula (in Appendix C) to estimate live weight for the animal concerned.

The second method is somewhat more complex due to the fact that all the comparative specimens do not have accurate live weight data. In order to arrive at the live weight estimates a series of comparative skeletons of the species to be estimated were weighed. The live weights for these comparative skeletons were calculated using the formulae

(Appendix C). The archaeological bone was then compared with the comparative skeletal series to determine which specimen it most resembled in size. The live weight estimate, computed for the comparative specimen closest to the archaeological bone in size, was used as an estimate for the archaeological bone as well. In some cases the archaeological bone fell, in size, halfway between the two comparative specimens. In these cases the average, estimated, live weight of the two specimens was used for the estimated live weight of the archaeological bone.

A third method for estimating live weight was used in certain cases where a series of comparative specimens were not available. In these instances a proporation was set up relating some particular measurement to skeletal weight for a comparative specimen and the archaeological bone. By this method the skeletal weight of the archaeological material could be estimated. This calculated, skeletal weight was then used in the relevant skeletal weight to live weight formula and the live weight estimated.

In a very few instances no measurable elements were present in the archaeological sample and another method for estimating live weight had to be used. This fourth method used the bone weight of the archaeological material to represent the skeletal weight of the animal and employed the formula for that class of animal. These estimates resulted in very low estimates and are probably only slightly better than no estimates at all.

In several cases none of the above methods could be used. For these animals, an estimate of average live weight from biological stuides, was used.

The above methods were employed to determine the live weights for the sites discussed in this study. Another method for estimating live

weight was also attempted. This last method used the archaeological bone weight as skeletal weight and calculated live weight using the relevant formulae. This was done to determine if the live weights estimated by this means differed significantly from the more complicated and time consuming method used in this study. The results of this comparison are included in Table 1. As can be seen, when the live weight are calculated by these two methods very different estimates are obtained. The different values resulting from the two methods and magnitude of their inaccuracies should be remembered when considering the estimates in Chapter 5. For this study the first method is used for the principal calculations.

The live weight or biomass estimates provide the basis for subsequent calculations. For seven sites where biomass calculations were taken, bar graphs illustrate the relative importance in terms of MNI and biomass of the various species from the sites. Edible meat weights were also computed from the biomass figures. Data on file at the Florida State Museum were utilized for these percentage of edible meat estimates. The entire animals, except the bones, was considered edible for all the species with the exception of mammals. The weight of skin, in addition to the bone of the mammals, is assumed to be inedible and, as such, was subtracted from the calculated live weight to determine the edible portion. Percentages used in these edible meat calculations appear in Appendix D. Having, in this manner, determined the edible meat weight, the calories and protein values of the foods were computed based on the figures published by Watt and Merrill (1975) and Leung (1961) (Appendix E).

When viewing the resulting charts and graphs certain points should be considered. The number of the individuals (MNI) of each species indicate the abundances of that species. Large animals may provide considerable food, but unless portions are distributed among members of

TABLE 1
COMPARISON OF METHODS USED IN ESTIMATING LIVE WEIGHT

Method I (used in this study)

	Mammals Calc. live wt.	%	Fishes Calc. live wt.	%
OGSE-80	52494	61	33813	39
OGSE-63	129055	95	6530	5
OGSE-46D	8324	15	47005	85

Method II (live weight calc. from bone wt.)

	Mammals bone wt.	Calc. live wt.	%	Fishes bone wt.	Calc. live wt.	%
OGSE-80	256.00	4417	82	49.75	979	18
OGSE-63	425.24	7387	90	38.38	800	10
OGSE-46D	28.35	475	5	344.03	8850	95

Formulas used in Method II

Mammals

Log (live wt.) = 1.0133 (log bone wt.) + 1.2049

Fishes

Log (live wt.) = 0.7775 (log bone wt.) + 1.6717

the community or some type of preservation is attempted, the meat not consumed will spoil. Smaller animals often supply a more reliable flow of food than the occasional large kill. Biomass indicates, in overall terms, the relative importance of a particular species in the diet. Viewing minimum numbers of individual and biomass estimates together, provides a more balanced picture of the day-to-day exploitation of animal protein foods.

Live weight or biomass estimates do not necessarily indicate the real value of a food source. Certain animals have a relatively high biomass figure, but actually contain little edible meat, e. g. turtles. The edible meat weight, although balanced by the fact that it introduces yet another estimate, is still a better indication of the actual food consumed. Assuming the estimates are accurate and that all the potentially edible parts were actually eaten, nutritional compilations, based on edible meat weights, suggest how efficient a particular food was in fulfilling basic protein and caloric requirements. A close consideration of the sizes of the animals, their feeding habits, and the habitats they occupy, provide information on exploitation patterns and procurement techniques.

The methods of identification and quantified described above furnish the bases for subsistence reconstruction of the sites considered below.

CHAPTER IV
CHANGING CLIMATE AND THE ECOLOGICAL SETTING

Human populations do not live in a vacuum and, as many researchers have pointed out, in order to arrive at an adequate understanding of a people's culture it is necessary to view a society in its ecological setting (Vayda and Rappaport 1968). This is particularly important if the research centers around the causal relationships or interrelationships between subsistence activities and the other aspects of culture. Without an appreciation of the resource availabilities, densities, and ecological patterns, subsistence strategies may appear incomprehensible. In ethnological studies an analysis of the area, with respect to resource availabilities and densities, seasonal abundances, productivity, and the nutritional value of the various foods, can provide the needed information to investigate the subsistence patterns. In archaeological research the problem is not as easily resolved. In some instances data exist which indicate that in the past the area of concern exhibited a different faunal and, probably, floral composition than is present today. The Santa Elena Peninsula is one such example.

The Santa Elena Peninsula

Today the Santa Elena Peninsula area is characterized by semiarid steppes with the extreme western part of the peninsula being an arid desert (Trewartha 1962; Sheppard 1930). Further north and east, tropical wet and dry savannas occur (Trewartha 1962). The vegetation is classified as xerophytic (Acosta-Solis 1970; Svenson 1946). Annual grasses

thinly cover the sandy soil of the area and small groves of dwarf trees and rounded shrubs are present along the arroyos (Svenson 1946). The average temperature at Ancon, on the peninsula, is 23.9°C with a high in March of 26.9°C and a low in August of 21.4°C (Acosta-Solis 1970). The average rainfall is 325 mm, with 97% of the precipitation occurring from January through April with March a particularly wet month (Acosta-Solis 1970). The other months are virtually rainless. These combinations of conditions result in a cold, rainless, foggy season (May through December) and a warm, rainy season (January through April).

The relative positions of the equatorial counter-current and the Peruvian, or Humbolt, current appear responsible for these seasonal conditions. The currents and their related winds also account for the west to east change from colder, drier coastal climates to the warmer, wetter area inland.

The Peruvian current originates in the South Pacific and flows north along the Chilean and Peruvian coasts. The main current veers west and away from the continent at about 5°S latitude, although one branch extends northward almost to the equator (Trewartha 1962; Schott 1932). The current experiences an offshore movement which is compensated by upwelling of colder waters from a greater depth (Trewartha 1962). This cold upwelled water appears to be one of the factors responsible for the arid conditions, the relatively low air temperature, and the fog or "garua" of the coast (Trewartha 1962).

The northern equatorial counter-current and the small El Nino current are "... genuinely tropical in origin and have a much lower salt content and much higher temperature... than those from the south" (Trewartha 1962:24). This northern current extends in diminishing force

to 6°S latitude, but generally heads west near the equator. Along the Santa Elena Peninsula, its main force is felt from January through April and brings with it the warmer temperatures, increasing rainfall and storms of the rainy season (Acosta-Solis 1970; Schott 1932).

Periodically the equatorial counter-current extends southward as far as Callao, Peru, dislocating the cooler Peruvian current. This results in torrential rains and massive flooding and erosion in the normally desert coastal Peru area (Murphy 1926). These rare occurrences seem to be due to the displacement of the "... equatorial convergence zones, together with its disturbances well to the south of its usual position to the north of the equator" (Trewartha 1962:32). These periodic shifts in currents appear also to have been important factors during prehistoric times.

Evidence of Climatic Change

Although the climatic history of South America is known in broad terms, information on more restricted locales is not always as readily available. In certain areas, however, information on past climatic conditions can be obtained. Reconstruction of the Recent climatic conditions for the Santa Elena Peninsula and the ecological settings of the area is possible, based on studies of an ocean core sample (Hough 1953) and archaeological research (Lanning 1967).

Akkaraju V. N. Sarma (1974) has attempted such a reconstruction. He bases his analysis on the relative percentage of "wet" or pluvial indications, i.e. mollusks who inhabit mangrove habitats which require alluvium from active rivers to grow, to the percentage of intertidal species which he believes "... were used for foodstuffs more frequently when the mangrove mollusks were absent" (Sarma 1974:129). He further

correlates his findings with paleoecological evidence from other areas of South America. He concludes

> Therefore, by analyzing the distribution of pluvial indicators, as opposed to dry-habitat indicators in shell-midden contents, the broad outlines of the climatic records were obtained. These pluvial periods seem to have occurred during the following periods: Vegas (6500-5000 B.C.); Valdivia (2650-1800 B.C. and 1700-1600 B.C.); Engoroy Guangala (1850 B.C. (850? B.C.) - A.D. 50)... When all the breaks in the seriations of the Peninsula are compared with climatic evidences, it is strongly suggested that periods when the Peninsula showed no archaeological records at all were periods of aridity. The reason seems to be that the availability of water was a critical factor and during arid phases people migrated to better and more hospitable regions (Sarma 1974:129-130).

Sarma assumes that the relative amounts of shells in the sites reflect their abundance in the area. Although this might have been the case, Sarma's reconstruction fails to take into account possible changing resource utilization patterns or food taboos.

Allison C. Paulsen uses Sarma's climatic shift model to explain obvious gaps in the ceramic chronology and changes in the Santa Elena Peninsula settlement pattern during the period from 500 B.C. to contact (Paulsen 1971). Although Sarma's and Paulsen's data appear mutually supportive, a more detailed review of an ocean core sample and zooarchaeological analysis discussed in this study suggests a somewhat different model of climatic change.

The reconstruction represented here includes information gained from an ocean core sample analyzed by Jack L. Hough (1953). The core sample was taken at 8°56.2' latitude and 29°05.2'W longitude, an area roughly due west of Chimbote, Peru. This core contained material dating back to 990,000 years ago, but of interest here is the segment dating from about 11,000 to the present. Analysis of this sample showed the

presence of globigerina ooze, which according to Hough (1953) indicates warmer waters than the area exhibits today. In addition, there are medium, dark brown, strata characteristic of conditions not much different than those at present and a dark brown zone composed of clays which were deposited during colder times. The core signifies warmer periods at about 7000 to 5000 years ago (5000 to 3000 B.C.) and during two shorter intervals, one at around 1900 years ago (A.D. 50) and the other at 100 (A.D. 850). These zones of ooze indicate that the northern tropical currents shifted radically southward at least as far as 9°S latitude with a corresponding dislocation of the Peruvian current. The Santa Elena Peninsula then assumed a more tropical configuration due to the southward movement of the equatorial currents during these times.

Two areas of dark brown strata, suggesting colder conditions, are present in the segment of the core of interest here. One colder cycle appears at about 3200 years ago (1250 B.C.) and another 2800 years ago (850 B.C.). These periods represent a northward shift in the position of the convergence of the two currents. Whether this shift extended far enough north to directly effect the Santa Elena Peninsula is unknown, but if it did, a colder and dryer climate would be expected. When the core sample is correlated with animal habitat information and human subsistence and settlement data the following reconstruction results (Fig. 2).

Climatic Change and Prehistoric Occupation of the Santa Elena Peninsula

6500 B.C.-5000 B.C. - Vegas Occupation

The earliest faunal remains considered in this study were left by the people defined in the Vegas Complex. This preceramic group exploited

Figure 2
CLIMATE CHANGE:
SANTA ELENA PENINSULA

Dates	Core Sample	Reconstruction	Occupation (Cultural)
A.D. 1000-1400	cool	savanna	Libertad
A.D. 800-11000	warm	tropical forest	uninhabited
A.D. 600	cool	savanna	Guangala (coast)
A.D. 50	warm	tropical forest	Guangala
550 B.C.-A.D. 50	cool	savanna	Engoroy - Guangala
850-550 B.C.	cold	desert	uninhabited
1000-850 B.C.	cool	savanna-desert	Machalilla
1600-1000 B.C.	cold	desert	uninhabited
3000-1600 B.C.	cool	savanna	Achallan and Valdivia
5000-3000 B.C.	warm	tropical forest	uninhabited
6500-5000 B.C.	cool	savanna	Vegas

the mangroves and coastal waters and also the savannas and forests of the area as the faunal remains from sites of this period testify. As Sarma (1974) points out, the presence of mangrove-specific mollusks indicates a moister environment during Vegas time than today. Water must have flowed nearly year round to provide the alluvium needed for the growth of the mangrove swamps (West 1956).

Data from the core sample suggest a relative cool climate during this period. Although cool, the area was warmer and wetter than it is today. Mangrove forests extended along the coast and savannas probably covered the inland areas. The river valleys and other areas might have supported some forest growth.

5000 B.C.-3000 B.C. - Uninhabited

Although an extensive survey was conducted on the Santa Elena Peninsula (Lanning 1967), no evidence of occupation of the locale had been found during this period. Sarma (1974) believes that this abandonment of the peninsula was due to increasingly arid conditions. Hough's (1953) ocean core sample, however, suggests that this period was a time of increasing warmth, probably resulting from a southward shift of the equatorial counter-current during this period. If this were the case, the Santa Elena Peninsula would have experienced increased rainfall instead of arid conditions and probably would have resembled parts of the present humid tropical forest of Columbia.

Studies of human subsistence in tropical rain forests suggest that for foragers and horticulturalists the quest for meat (i.e. protein) is of primary concern (Carneiro 1961; Gross 1975; Lathrap 1973; Holmberg 1969). In the tropical rain forests, species densities are low and, with the exception of a few terrestrial animals, most inhabit the high

forest canopy and are, therefore, hard to obtain. Only along major rivers, rich in aquatic protein resources, did large concentrations of people occur (Meggers 1971). On the interfluvial areas and along rivers with low nutrient levels only small population aggregates were supported. Gross (1975) has suggested that this is due to the very low carrying capacity of these areas with respect to protein sources. Due to this, many agriculturally productive, but protein-poor areas, experience low population densities. The Vegas people, faced with the encroachment of the tropical forest, presumably also experienced the pressures of protein scarcity.

Presented with this problem, the Vegas people had three alternatives: (1) they could leave the area; (2) they could try to get along on decreasing amounts of protein by radically reducing their numbers and extending their range; or, (3) they could move to the rivers and shores to attempt to exploit the aquatic protein sources there. The rivers of the western Andean coast support relatively few, riverine, fish species (Eigenmann 1921). The coastal area experiences a greater range and abundance of fishes or sea food, but the Vegas groups did not appear to have a technology adequate to exploit these marine resources to their fullest extent. They seem to have adopted the first alternative and left the area.

<u>3000 B.C.-1600 B.C. - Achallan and Valdivia Occupation</u>

Between 3000 B.C. and 1600 B.C. the Santa Elena Peninsula was once again inhabited. Early members of this migration brought with them the Achallan Cultural Complex (Stothert 1974). Another wave of people, entering the area at the same time or a little later than the Achallans, was the Valdivians. This latter group is reputed to have introduced

agriculture into the general area (Lathrap 1975). These new people exploited many of the same habitats that the Vegas groups had found productive. Both the faunal remains and the ocean core sample characterize a climatic shift back to the mangrove wooded coast and probably the inland savannas and forest of the Vegas period.

<u>1600 B.C.-1000 B.C. - Uninhabited</u>

Based on the lack of archaeological evidence, this period is believed to represent another time of abandonment of the Santa Elena Peninsula (Sarma 1974). The ocean core indicates much colder waters around 1250 B.C., presumably resulting from the northward shift of the Peruvian current. The movement of this cold southern current into the peninsula area could have brought about colder, drier conditions. The increasing aridity rendered agricultural and hunting subsistence methods increasingly inefficient, and evidently lead to the abandonment of the area.

<u>1000 B.C.-850 B.C. - Machalilla Occupation</u>

Sarma (1974:117) suggests that the Machalilla "... occupation of the peninsula took place in an arid time and was brief." When correlated with the core sample this cultural manifestation does fall between two, short, cold periods giving some support to Sarma's position. It should be noted, however, that the area was sufficiently moist to support mangroves (Sarma 1974).

<u>850 B.C.-550 B.C. - Uninhabited</u>

Sarma interprets no break in occupation during this time. The core sample, however, reflects another cold period around 850 B.C.,

which was probably of approximately the same intensity as the 1250 B.C. episode. The Santa Elena Peninsula was abandoned during the former dry period, and, although not conclusive in itself, a gap in Sarma' radiocarbon dates support this as a possible third period of abandonment. Paulsen also notes a gap of around 200 years in the ceramic occupation of the Santa Elena Peninsula between the Machalilla and Engoroy times, but she dates this break at 1100 B.C.-900 B.C. (Paulsen 1971).

550 B.C.-A.D. 800 - Engoroy and Guangala Occupations

Both Sarma (1974) and Paulsen (1971) see a continuous occupation of the peninsula during this 1350 year span. Again during this period mangrove species are found in the middens. The presence of a fox (Dusicyon cf. sechurae) from a midden of the early part of this span (Engoroy) suggests that dry savannas or semi-deserts could have existed inland. Information on the terrestrial vertebrates of the later Guangala period is not available. The only site analyzed from this time period contained no terrestrial forms of food value.

For this general time range Hough's core sample indicates both a cool period formerly correlated on the Santa Elena Peninsula with savannas and a warmer span presumably similar to, but of shorter duration than the 5000 B.C.-3000 B.C. episode. This warmer period would have occurred around A.D. 100. This should have resulted in a return of forest conditons. Neither Sarma nor Paulsen note any human displacement at this stage. Paulsen does indicate a move of people during Guangala Period VI times. At A.D. 600 this resulted in the abandonment of the inland sites located near man-made catch basins and the movement of the populations to the shore areas (Paulsen 1971).

As indicated in the Pacific core sample, increasingly warmer conditions were felt again around A.D. 800. Possibly the encroaching humid tropical forest, which would be experienced in the more northerly Santa Elena Peninsula area earlier than A.D. 800, could have resulted, as in the case of other tropical forest areas, in more competition over the increasingly scarse protein foods. This pressure might explain the initial movement of the Guangala people from the now protein-poor basin areas to the more protein-rich shore. This may also account for the ultimate Guangala abandonment of the peninsula.

A.D. 800-A.D. 1000 - Uninhabited

Contrary to Sarma's reconstruction, Hough's analysis of the Pacific core sample indicates that in this area the equatorial counter-current had again shifted south during this period, bringing with it a return of warm, moist conditions. Tropical forest vegetation presumably once more covered the Santa Elena Peninsula and during this period the Guangala people appear to have abandoned the peninsula.

A.D. 1000-A.D. 1400 - Libertad Occupation

During this time period the Santa Elena Peninsula again supported a human population, this time members of the Libertad Culture. Although cooler than the preceeding 200 years, the areas was still moist enough to support mangrove stands. The only vertebrate, zooarchaeological collection available contained no terrestrial species that could provide climatic indications. Based on the evidence of a preceeding moist climate and the subsequent semi-arid and arid conditions extant today, presumably the Santa Elena Peninsula was passing through a transitional savanna stage.

Summary

As Hough's (1953) core sample indicates, the Santa Elena Peninsula was apparently subjected to periods of high aridity resulting in semi-desert conditons and to episodes of increasing warmth and moisture leading to the development of humid, tropical forests. The archaeological evidence suggests that both climatic extremes generally resulted in the abandonment of the area. Without substantial changes in the technological exploitation base and the related modification in certain cultural institutions, the various peoples were unable to adequately utilize the area's available resources.

In addition to the radical climate changes described above, the Santa Elena Peninsula, during its 7500 years of sporadic human settlement, undoubtedly experienced both seasonal and, at irregular yearly intervals, minor climatic fluctuations as it does today. These would result from relatively slight shifts in the positions of the ocean currents. The overall effect of these minor episodes on the prehistoric peoples need not have been great.

Although the Santa Elena Peninsula furnishes the main focus for the reconstruction above, the focus of interest in this study encompasses a somewhat larger region. Areas a little further north would be affected slightly earlier by any southward movement of the currents and later by the northward displacement. Inland areas, both to the north and east, would be slightly less influenced by either shifts, a result of their positions relative to the currents and coastal winds.

CHAPTER V
FAUNAL ANALYSIS AND RECONSTRUCTION

The previous chapters presented the theoretical framework and methodology for this study. This section concerns the identification and analysis of the faunal material from the various sites. It is an attempt to arrive at an understanding of past subsistence patterns and exploitation techniques. The following chapter summarizes these findings for the cultural phases and identifies the subsistence-related, human behavioral patterns practiced by the various populations.

For ease of presentation, the archaeological sites are divided into three main groups, pre-Valdivia, Valdivia, and post-Valdivia. The Valdivia section is further divided into coastal and inland sites. For each of the groups considered in this study, some general remarks on the cultures as a whole, and particularly on other subsistence aspects of the people, are included.

Each site is then considered. Appendix A contains the detailed information on species present and their MNI, their number of fragments, and their bone weights. Appendix B tabulates the biomass, edible meat, calories and proteins estimated for certain of the sites. The text of this chapter provides summary observations on the species present and their relative importance in fulfilling the people's nutritional needs. This suggests the value of the various vertebrate resources in the diet of the people. Next, the technology used to obtain the food resources are examined. Where available, artifactual evidence, i.e. projectile

points, fishhooks, etc., is considered, but the discussion of exploitat-tion techniques largely depends on the habits and habitats of the principal species present. Information on the relative importance of the various animals and on their habits and habitat preferences provide the basis for observation of possible subsistence-related, human behavioral patterns.

Pre-Valdivia

Materials from three sites on the Santa Elena Peninsula provide the data for the pre-Valdivia group. Two of these sites exhibit Vegas affiliations while one has been assigned to the newly defined Achallan Complex (Stothert 1974).

Vegas Complex

The preceramic, Vegas Complex represents some of the earliest archaeological material yet discovered on the Santa Elena Peninsula. Dated at between 6500 B.C. and 5000 B.C., this cultural manifestation consists primarily of shell middens located along the western section of the peninsula (Stothert 1974). Excavators have uncovered several types of stone tools from Vegas period middens including side- and end-scrapers, flake knives, gravers, denticulates and spokeshaves (Willey 1971). Heavy duty choppers, grindstones, and hammerstones also have been found (Stothert 1974). No bifaces or stone projectile points have as yet been uncovered.

In his summary of the Vegas Complex, Gordon R. Willey states that

> ... the shoreline sites are shell middens - which offer our only direct evidence of marine subsistence- and Lanning suggests that the former midden dwellers might have followed a seasonal round of winter

> shellfishing at the beach and summer plant gathering and fishing along the streams (Willey 1971:262).

As is seen below, this does not appear to be entirely the case. From the faunal sample from the two Vegas sites analyzed, both sea turtle and marine fishes were identified in considerable numbers. Although these samples provide no evidence to either support or refute seasonal occupation of the Vegas sites, a seasonal shift in subsistence emphasis is common for many largely hunting and gathering peoples. It should be noted, however, that today and presumably for some time in the past, the western slopes of the Andes and the coastal strip have been characterized by a relatively impoverished, freshwater, fish fauna (Eigenmann 1921). Also certain climatic factors characteristic of the area cause periodic desiccation of the Santa Elena Peninsula. This results in the destruction of the meager, freshwater, fish fauna. It is interesting to note that, with the exception of two, freshwater catfish, no freshwater forms were found in any of the middens considered in this study. Although this could simply reflect cultural selection of marine forms, it might indicate the exceptionally low densities of freshwater fish populations and, therefore, little or no advantage in fishing the freshwater streams.

<u>OGSE-80</u>

The remains from OGSE-80 represent the largest, pre-Valdivia, bone sample available for analysis. It is, therefore, particularly important. OGSE-80 is located about 3.5 km from the sea and is a shell midden site with a Vegas occupation overlaid by a shallow Valdivia deposit. Three different types of burials were found in the midden. Karen Stothert, the excavator of the site, believed two of these were of Vegas affiliation. The third she identified as possibly an intrusive Valdivian burial type.

Faunal remains. This Vegas midden contained the bones of a wide variety of vertebrates, including humans. The human remains show no indications of cannibalism. The human bones were scattered in the midden, a pattern characterisitic of food refuse, but it is reasoned that, since the midden functioned as a burial area, these human bones could well represent burials that were dislodged by later interments. For these reasons, the human bones are not viewed as food remains and have been deleted from consideration. The only other evidence of the use of vertebrates for other than or in addition to food purposes was the presence and location of a large number of fox teeth (Stothert 1974). The teeth were included in a burial as grave goods. Other vertebrate remains found at the site presumably represent Vegas food items.

In terms of numbers of individuals, rodents are the most abundant mammal collected for food. This large number of rodent remains is surprising due to the nearly total lack of these animals in other midden samples considered in this study. The rodents from OGSE-80 are a small, rat-like animal and, although numerous contributed relatively little meat to the aboriginal diet if they were in fact used as food and not merely incidental to the site.

The fox remains constituted both more individuals and more meat than the rodents, but not all the remains of the fox can be assumed to be food refuse. Stothert, while excavating the Vegas type III burials noted three, conical, piles of fox teeth distributed around one human skeleton. Analysis of fox teeth from the total OGSE-80 sample and the calculation of the minimum number of individuals (MNI) they represent indicates that the excavated portion of this site contained the remains from at least 27 foxes. When the MNI is calculated on skeletal parts,

other than teeth, at least four individuals are represented. The MNI of four undoubtedly represents a more reliable estimate of the importance of fox as a food source at this site. For this reason subsequent calculations of the dietary importance of the fox is based on a MNI of four.

Although less numerous than either rodents or foxes, the deer provided by far more edible meat (41%) than any other vertebrate source. The size of the deer bones are rather small and are probably from the relatively small, brocket deer (Mazama). Other mammals found in the midden that are both less numerous and presumably of less nutritional importance include rabbit, weasel, and an unidentified fox-like mammal. These animals functioned as additional meat sources for the Vegas inhabitants.

Although mammals represented the most important vertebrate food (c. 59% of the edible meat), fish also contributed considerable meat to the diet (40%). Catfish and drum were particularly abundant, although the less common shark, snook, jack, and tuna actually supplied more meat providing more proteins and calories. Additional fish sources were ray, snapper, grouper, and mullet.

The Vegas material contained several other vertebrates including frog, snake, sea turtle, and parrot. These remains represent a minor food component of the diet. Figure 3 summarizes the MNI, biomass, edible meat, calories, and protein estimates for this site.

Reconstructed hunting and fishing patterns. Although there exists little artifactual evidence of stone or bone hunting and/or fishing equipment, some observations on procurement techniques can be made using the principal faunal remains themselves. The Vegas people apparently hunted fox for two principal reasons, for food and for the teeth that were

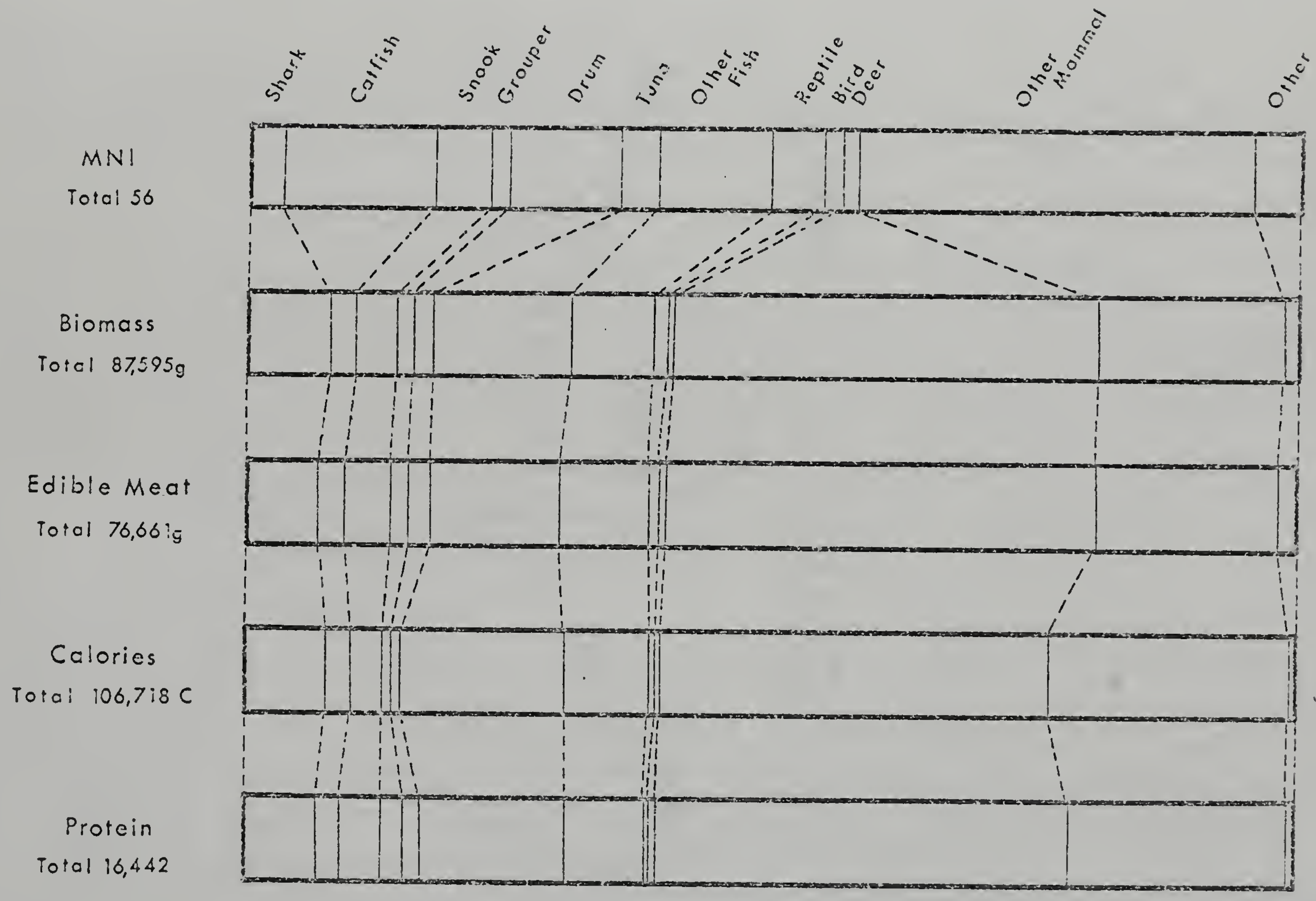


Fig. 3

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
OGSE – 80

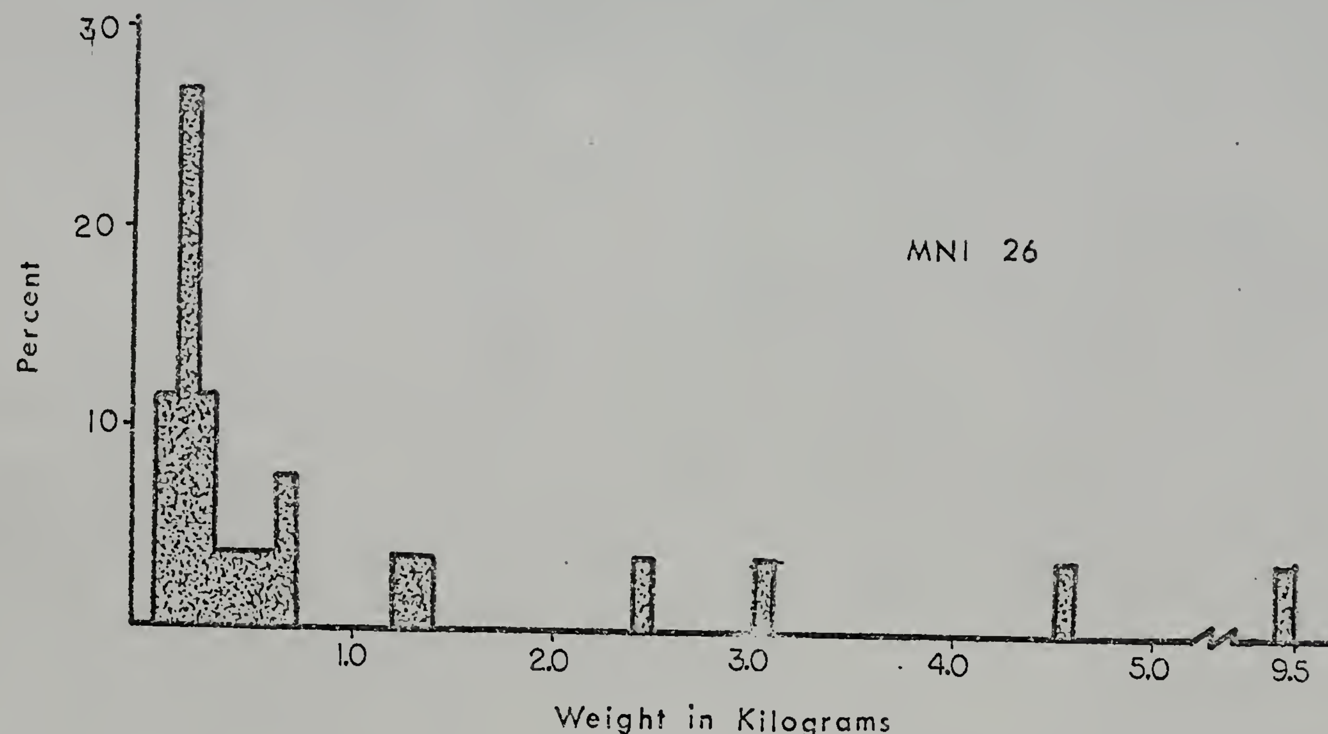


Fig. 4

DISTRIBUTION OF WEIGHT OF CAPTURED FISH

OGSE – 80

interred with one of the burials at the site. This suggests some type of specialized hunting or at least the retention of the teeth of this animal. The emphasis on fox hunting becomes particularly apparent when the OGSE-80 remains are compared with those from other sites where fox bones are uncommon or absent.

No direct evidence exists to indicate how the Vegas people obtained either these foxes or the single deer found at the site. Several possible methods could have been effective in capturing these animals. These methods include the use of some type of projectiles or traps of either the snare or death fall types.

The rodents are basically nocturnal animals and forage from the late afternoon to early morning. This time span generally represents a period of low hunting activity by the human predators. The rodents are also of relatively small size (about 80 grams live weight), and, as such, direct hunting methods, e.g. single stalking of the animals, would result in little return for the energy expended. Trapping would probably represent the most productive method for obtaining these small, nocturnal animals. They might have been attracted to the rubbish around the camp and trapped there.

Most of the fishes found in the midden are indiscriminate carnivores and readily take a baited hook. This method could have been utilized to catch them. The mullet, a fish that cannot be easily caught with a baited hook, must have been taken by another method, possible by spearing or hand-catching or, as the southern United States blacks do, by wrapping filamentous algae around hooks (Wing 1976b). Although some of the fishes are fairly large, about 9500 grams, most are smaller, under 700 grams, with the majority in the 100 to 200 grams range (Fig. 4).

No evidence, such as large numbers of herds of terrestrial animals or schooling fish species, which might indicate that the people practiced cooperative hunting and/or fishing was found in the sample. In fact, the fish remains suggest that cooperative fishing was not practiced. Fishermen working singly or in small groups probably were the most efficient way of obtaining the fishes represented in the midden.

OGSE-38

The shell midden OGSE-38 is the other Vegas Complex site considered in this study. Like OGSE-80, this site is located on the Santa Elena Peninsula. It is situated, however, nearer to the shoreline. Originally it was expected that this site would demonstrate either close similarities with OGSE-80, indicating a general subsistence exploitation pattern despite slight differences in ecological setting for Vegas sites, or a different resource focus suggestive of a modification of subsistence base to take advantage of the more readily available resources. Unfortunately, the small size of the OGSE-38 sample makes it impossible to test either hypothesis.

Faunal remains. The small sample from OGSE-38 does indicate that these Vegas people utilized many of the same resources as the OGSE-80 group including fox and rodent and the marine forms, catfish, jack, mullet, and sea turtle. This site did include the puffer, a fish absent from the other Vegas midden. Due to the extremely small size of this sample no biomass, edible meat weight, calories or protein estimates were attempted for this site. It would seem, however, that terrestrial forms or the sea turtle were probably the most important food sources.

Achallan Complex

The Achallan represents a recently defined cultural complex. Stothert believes, based on her work at OGSE-63, that the Achallan "... showed some technological impoverishment" (Stothert 1974:14) when compared to the Vegas group, but had added rather crude ceramics to their cultural inventory. To date only one site, OGSE-63, has been assigned to this complex. Its assignation is based on detailed lithic analysis (Stothert 1974) and it has been carbon dated at around 2700 B. C. Stothert believes this date too recent and suggests the middle of the 4th millennium B.C. as more accurate.

OGSE-63

This site is located along the Rio Achallan on the Santa Elena Peninsula. Stothert suggests that originally the site consisted of a ring of small middens containing shell.

As in the case of OGSE-38, the zooarchaeological sample from this site is small. Nevertheless, since it represents the only material from this period, and could be viewed as intermediate between Vegas and Valdivia, biomass, edible meat, calories, and protein estimates are computed (Fig. 5). Because of the small sample size these estimates could include considerable error.

Faunal remains. When this Achallan material is compared with earlier Vegas samples certain dissimilarities appear. This is particularly evident when examining the mammal remains. While the two Vegas sites exhibited a wide subsistence base, the Achallan people were more selective. The fox and rodent, that are well represented in the Vegas faunal samples, are lacking in the OGSE-63 material. Deer is the only

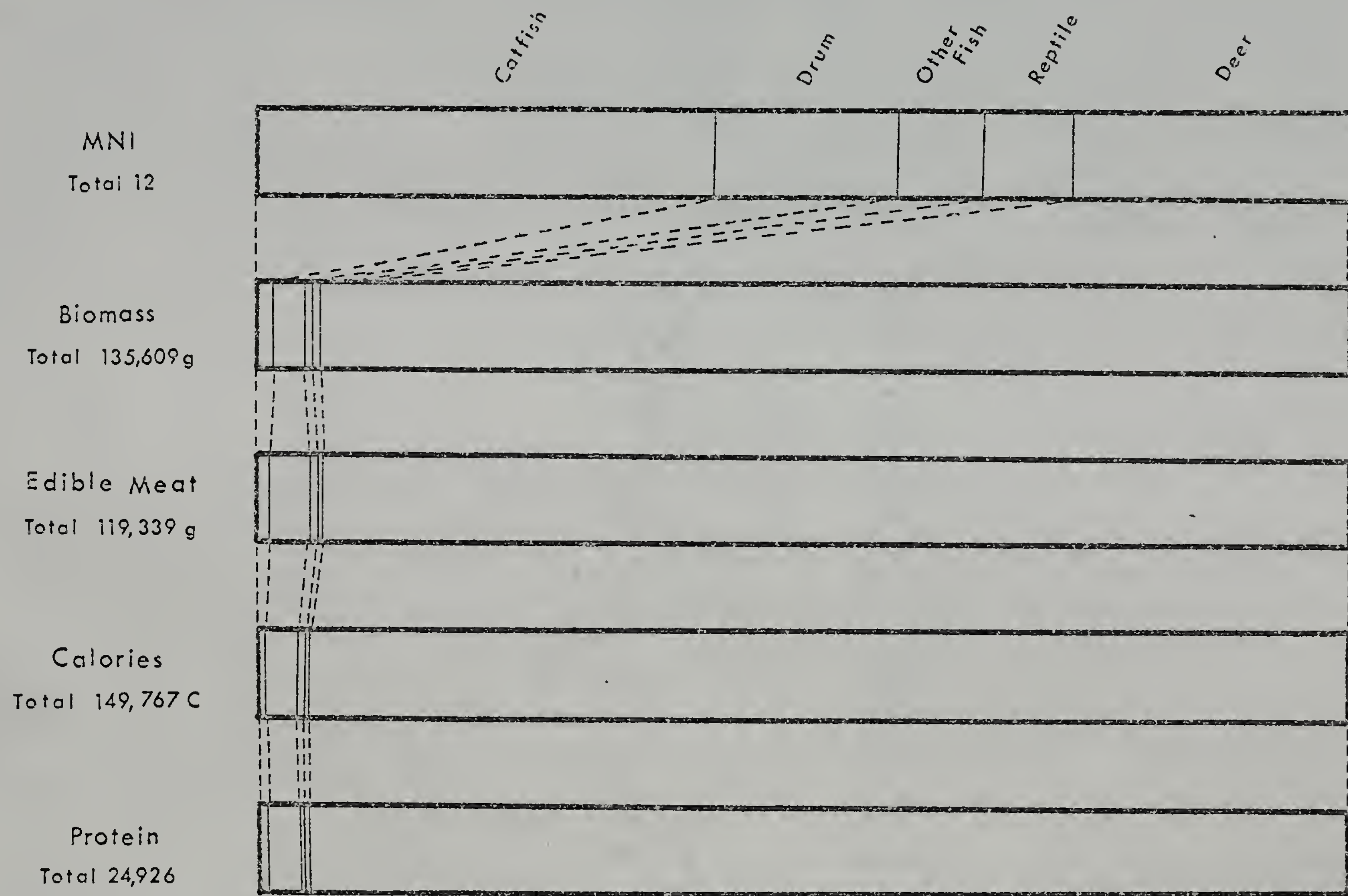


Fig. 5

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
OGSE – 63

mammal present at this site. By a comparison of the sizes of the bones two species of deer appear in the midden, the larger white-tailed deer and the smaller brocket.

The amphibians, snakes, and bird bone present in the Vegas sites are missing from the Achallan sample. This might be the result of the small size of the sample. The fishes exploited are not markedly different in type than those from Vegas sites and presumably represent a continuation of Vegas-like fishing patterns.

Valdivia Phase

The Valdivia Phase represents the early Formative manifestation in Ecuador and one of the earliest Formative phases in the New World. As such, it provides an excellent opportunity to study the gradual shift from nomadic hunting and gathering to sedentary horticulture. How this shift came about and under what conditions it occurred is the interest of many researchers.

Some scientists believe that early sedentism was possible on the Ecuadorian coast because of the abundant and reliable food found in the coastal area, i.e. shellfish and fish (Meggers 1966). These researchers note that, at the same time as early Valdivia, coastal Peruvian groups were already cultivating beans, squash, bottle gourds and cotton (Lanning 1976b). They suggest that the early Valdivians had more or less permanent settlements on the coast where they exploited the local food resources and possibly, like their Peruvian neighbors to the south, engaged in incipient agriculture (Meggers 1966). The Valdivian people theoretically supplemented their marine protein resources by occasional hunting trips inland.

Other researchers (Lathrap 1975) believe that the Valdivia people were engaged in substantial agricultural practices as early as Valdivia I times (c. 3400 B.C.) and were well established by Valdivia III (c. 2500 B.C.). These archaeologists find support for this hypothesis in the location of the sites, the presence of storage pits and grinding implements.

The presence of agriculture and its importance in the diet is an interesting question, but one that is difficult to study. Conditions on the periodically wet Guayas coast result in poor preservation of plant remains and, to date, no direct evidence of substantial agriculture for this period has been unearthed. Indirect evidence (Lathrap and Marcos 1975) and analogies with other areas of the same time period (Meggers 1966) suggest that the early Valdivians could have practiced agriculture at least in its incipient forms. Presumably, increasing reliance was placed on agricultural crops through time. Although plant foods including agricultural products are important components in a diet, animal protein sources are as important, if not more important, than plant foods in supplying needed nutrients, especially protein. What protein sources the Valdivians used and how they obtained the animals is the question that is considered here.

Certain similarities are found in all the Valdivia sites studies below, but it would be erroneous to speak of a "Valdivia hunting and fishing pattern". Considerable differences are evident among the sites, especially when comparing the Santa Elena Peninsula sites with those either inland or farther north. Some of these differences are undoubtedly attributable to local biological and ecological factors, such as the

presence of habitats particularly favored by certain species, while other differences are more easily explained as resulting from cultural patterns and practices.

Coastal Sites

Zooarchaeological materials were available from five coastal samples, four of which were located on the Santa Elena Peninsula and the fifth is to the north at the mouth of the Valdivia River. Two of these samples came from one site, OGSE-62 (numbered OGSE-62 and OGSE-62C). OGSE-62C was assigned to the middle Valdivia (Stothert 1975) subphase, while OGSE-62 is simply listed as Valdivia. These two samples could have been regarded as one unit, but they are considered individually here. It was felt that treating these samples individually provided the opportunity to study the variability within a site. For this reason biomass and food value estimates, as well as relative number charts and fish size graphs, are constructed for each sample. The other two Santa Elena Peninsula sites were too small for any kind of reliable estimates. Faunal lists and a short description of the remains are included for these sites. The fifth Valdivia site, the one from which this cultural phase takes its name, is considerably different from the Santa Elena Peninsula sites both in species present and the size of the individuals. Material from this site suggest a slightly different subsistence emphasis.

OGSE-42

OGSE-42 represents the Valdivia Phase I occupation on the Santa Elena Peninsula. Based on ceramic similarities and dates from the Phase

I, Loma Alta site, OGSE-42 was occupied around 3400 B.C. (Bischof 1972), although the actual dates, based on shell, were later (Stothert 1974). Karen Stothert, the excavator of the midden, believes that this site was occupied for a fairly short period of time and that the midden deposit itself may have been in the form of a ring, as in the case of the Achallan Complex site OGSE-63 (Stothert 1974).

When the animal bones from this site were first submitted for analysis it was thought that this material might show a subtle shift in exploitation emphasis. If this shift in protein utilization had occurred it might be correlated with the introduction of a new culture type which possessed at least incipient agriculture. Although the material from OGSE-42 contains some elements suggesting a shift, i. e. decreasing amounts of terrestrial forms, the sample was so small that this apparent change may be the result of the sampling itself.

Faunal remains. The species found in the midden material include brocket deer and marine catfish, snook, drum, and sea turtle.

OGSE-62 (OGSE-62C)

OGSE-62 is situated about 100 meters south of the Achallan Complex site, OGSE-63, discussed above. Occupation at this site began during Valdivian Phase III times (c. 2500 B.C. Lanning 1968) and continued through Valdivia V (Stothert 1974). As in the case of OGSE-63 and OGSE-42, the midden at OGSE-62 was distributed in a form suggestive of a ring of small deposits (Stothert 1974).

Although similar to Achallan in location and settlement, here similarities stop. OGSE-62 (OGSE-62C) had both a much more elaborate ceramic inventory and, more important for this study, a very different

protein base. This latter difference is not explainable on site location along since both sites are situated relatively close to each other. Although a shift in the climate, in the highly variable Santa Elena Peninsula area, could explain the different numbers of species present, the difference could also be due to a shift of exploitation emphasis.

OGSE-62

Faunal remains. The vertebrate faunal remains from OGSE-62 are almost entirely marine (98.9% MNI). Principal abundant species include the catfish (41.9%) and the grunts (31.4%). Other important fishes represented here were the grouper, jacks, snappers, and porgies (Fig. 6). Due to the larger sizes (Fig. 7) of these numerically fewer fish, the groupers, jacks, snappers, and porgies contributed more meat than the catfish and the grunts. Both numerically and nutritionally minor components of the diet are the sea turtle and a mammal. The true nutritional importance of these last two animals are considerably underestimated due to the method of calculating their live weight, but the relative importance of these resources, versus fish, is probably not too accurate.

OGSE-62C

Faunal remains. The material from OGSE-62C resembles in many respects the preceeding sample. Nevertheless, these remains include proportionally more catfish (63.6%) and fewer grunts (25%) than at OGSE-62 (Fig. 8). Also fewer species are represented. Due to the overall size distribution (Fig. 9) the fishes from OGSE-62C actually contributed more meat in weight than those in the OGSE-62 sample. Numerically minor species in this sample included the snook, grouper, jack, and porgy.

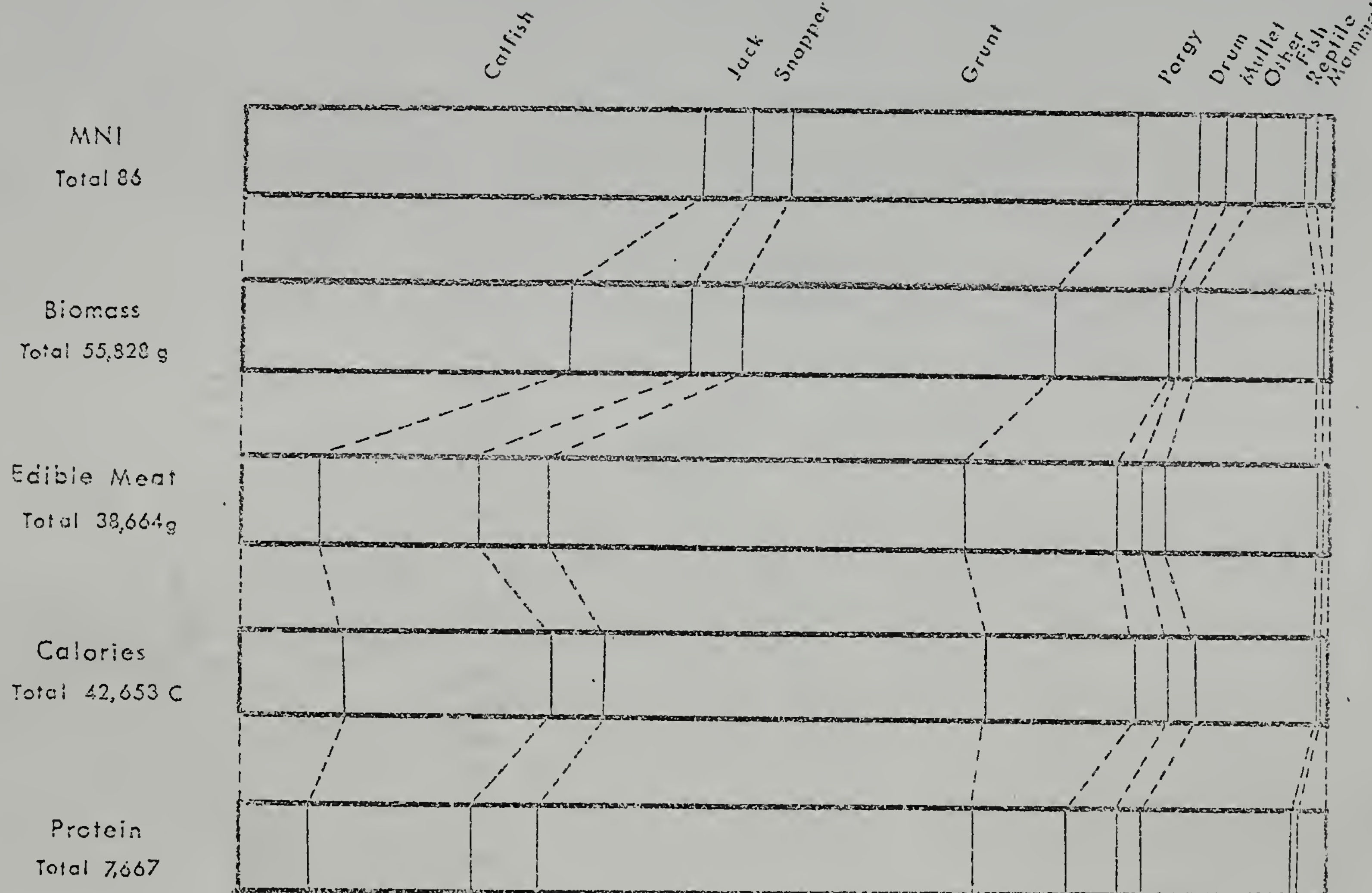


Fig. 6

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
OGSE - 62

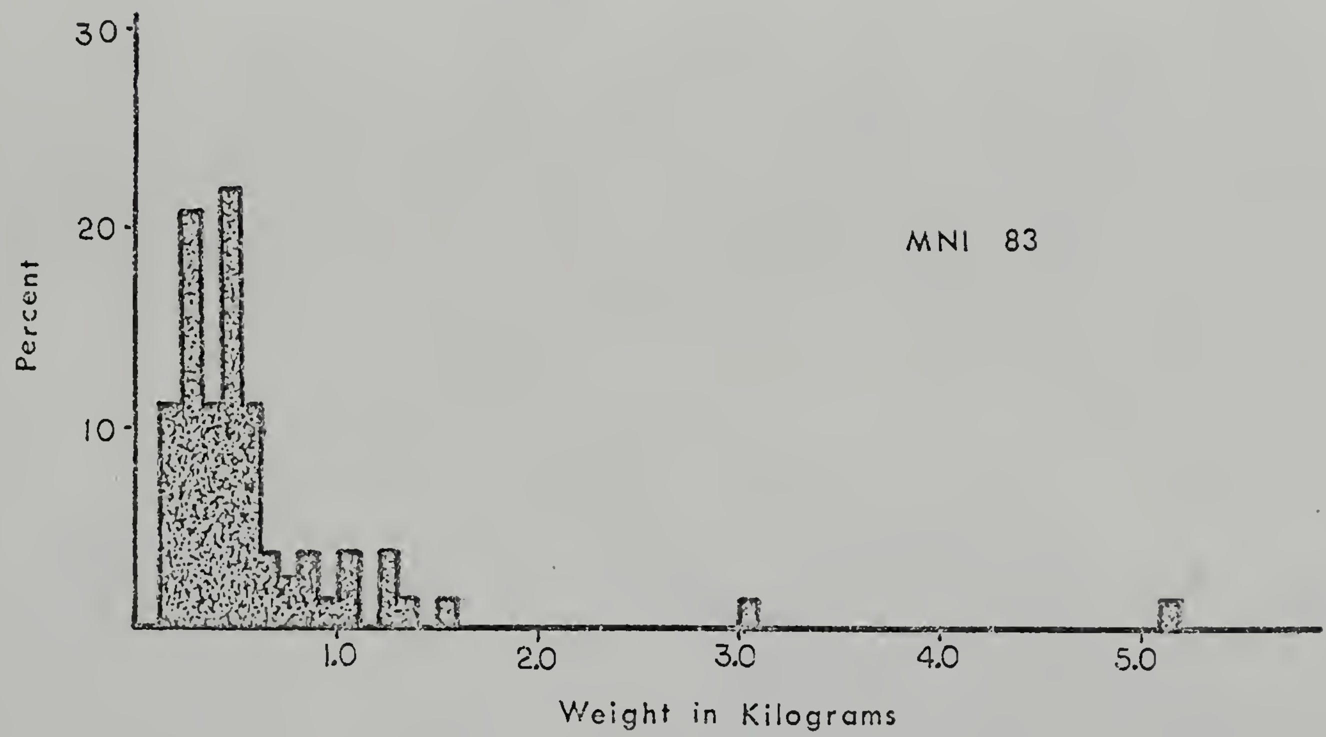


Fig. 7

DISTRIBUTION OF WEIGHT OF CAPTURED FISH

OGSE — 62

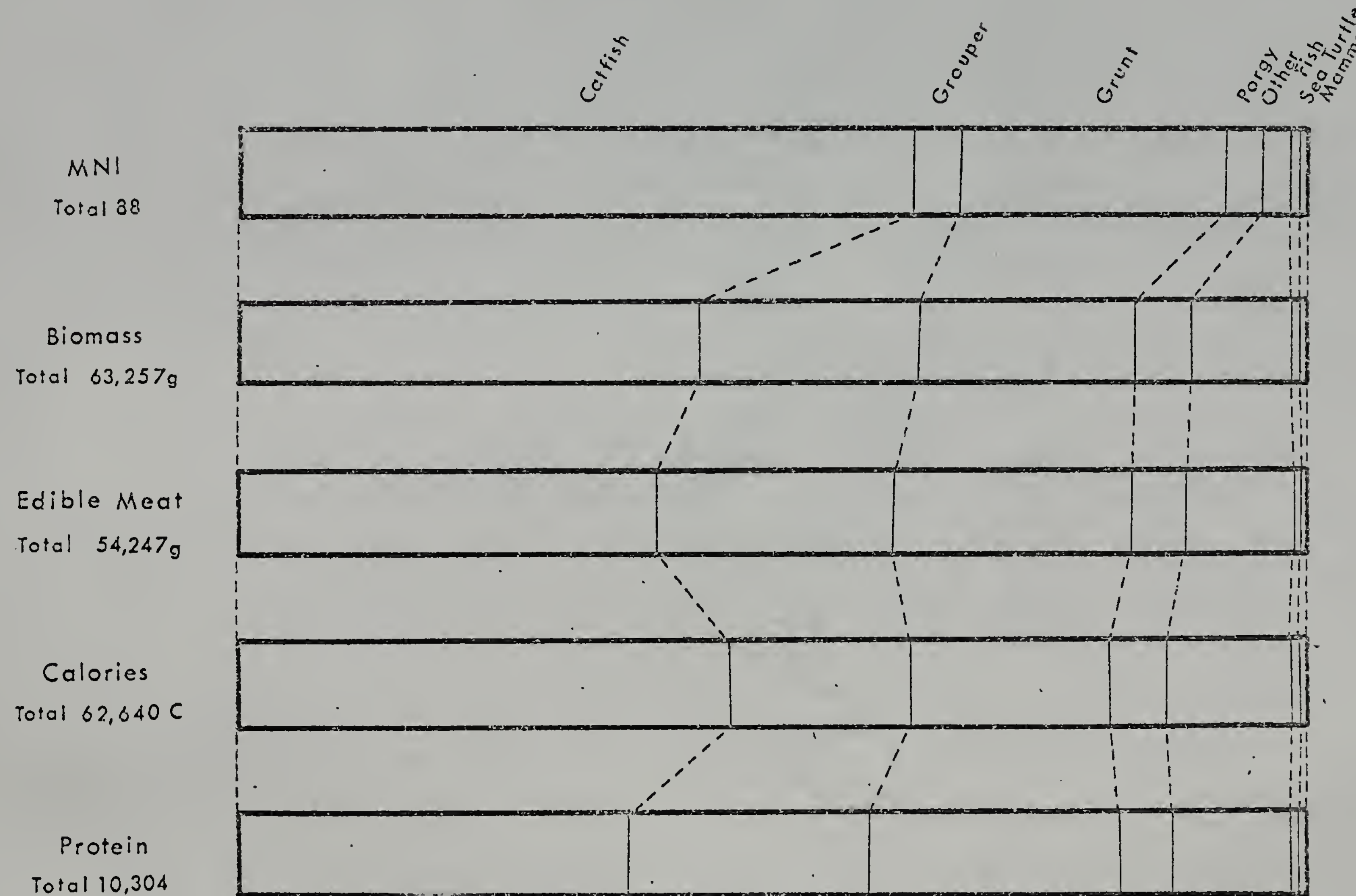


Fig. 8

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
OGSE - 62C

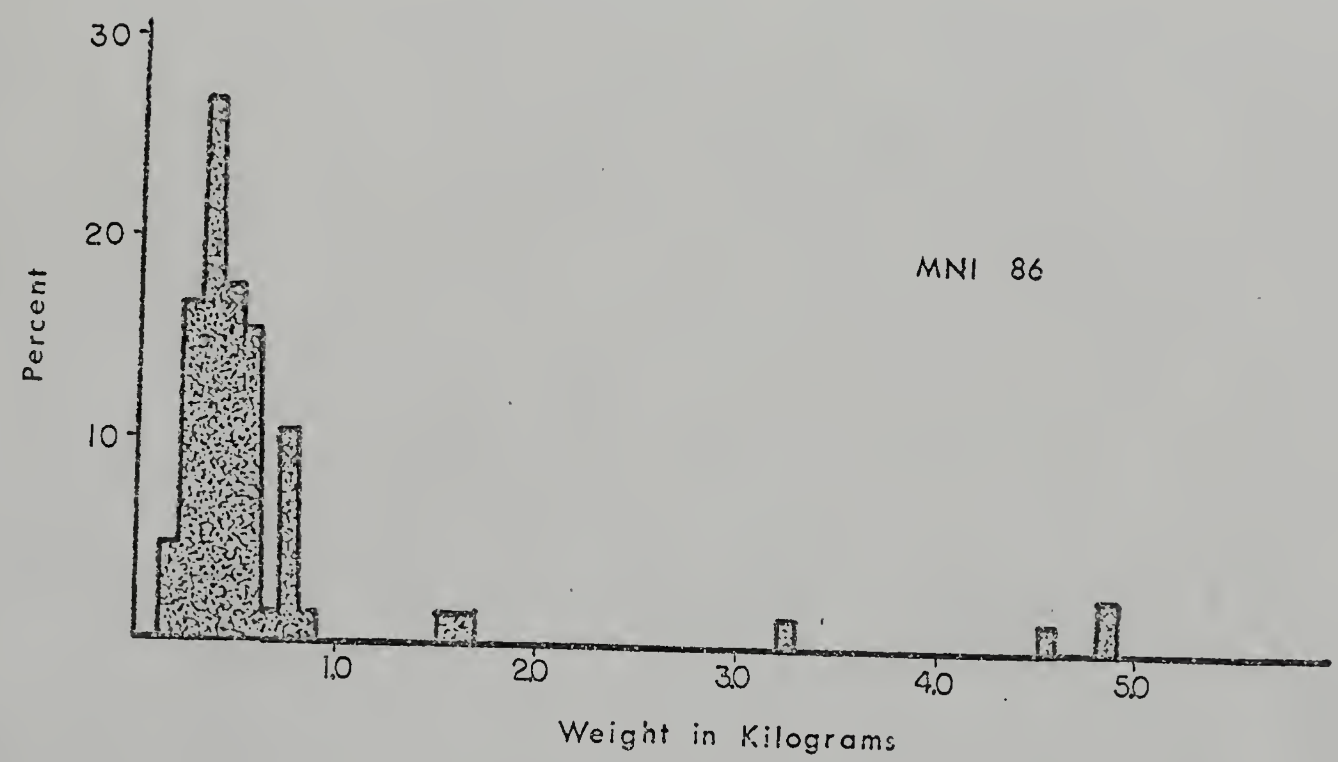


Fig. 9

DISTRIBUTION OF WEIGHT OF CAPTURED FISH

OGSE — 62 C

OGSE-62 and OGSE-62C

Reconstructed hunting and fishing patterns. When OGSE-62 and OGSE-62C are compared, several differences become evident. Particularly noticeable is the wider range of species present in the OGSE-62 sample which are absent from OGSE-62C. These species account for 9.4% of the MNI from OGSE-62. This need not be as important as it first appears. All the species represented in the samples (with the exception of mullet) are inshore carnivores and can be taken with a baited hook and line. Shell fishhooks have been found in Valdivia middens and these hooks range in size from about 1.8 cm. by 2.0 cm. to 2.5 cm. by 2.8 cm. (Meggers, Evans, and Estrada 1965). The seemingly disproportionate representation of certain forms could simply represent fish caught on a day or season of the year when "the snappers were running" or result from a particular fisherman's attachment to a particularly good fishing area.

Another method had to be used to catch the mullet. Mullets are herbivores and as such are not readily taken by a baited hook and line. One effective method for catching this fish is using nets either of the gill net or seine type. This could result in the capture of large numbers of this schooling species. Weirs and traps could also result in numbers of mullets as well. In any event, only two individuals of this species were identified from the samples. If nets or some other collective techniques had been regularly used on this abundant species more individuals would be expected. This suggests that none of these methods were employed. The Valdivian fisherman could have resorted to spearing, or hand catching or algae-baited hook to catch these herbivorous animals.

OGSE-174

OGSE-174 represents another Santa ELena Peninsula midden. No subphase association is available for this Valdivia site. If, however OGSE-42 and OGSE-62 are representative of Santa Elena Peninsula coastal middens, the relatively large representation of mammal remains suggests an early Valdivia affiliation.

Faunal remains. Although three deer were identified from this site only one is assignable to a species, i.e. *Odocoileus*, the other deer material was either too fragmentary or of a size that made species correlations impossible. The marine resources represented in this midden resemble those from other sites discussed. Again the catfish and the grunt are particularly abundant. Snook, jack, and sea turtle also occur.

Valdivia

The Valdivia site material is the only Valdivia coastal site outside the Santa Elena Peninsula area considered in this study. This site is located north of the peninsula and at the mouth of the Valdivia River (Fig. 1). The ceramic and lithic material from this site formed the bases for the original description of the Valdivia Phase (Meggers, Evans and Estrada 1965).

Faunal remains. The vertebrate fauna from the Valdivia site differs somewhat from those discussed above. At this site terrestrial species include the peccary and two types of deer, the white-tailed, and the brocket. Based on comparisons of the size of the deer bones, the larger white-tailed deer appears more common in the midden. Catfish are still a common fish in the midden, but at Valdivia snook is also abundantly represented (Fig. 10). More meat was available to the people from snook and deer sources than all other sources combined (Fig. 11).

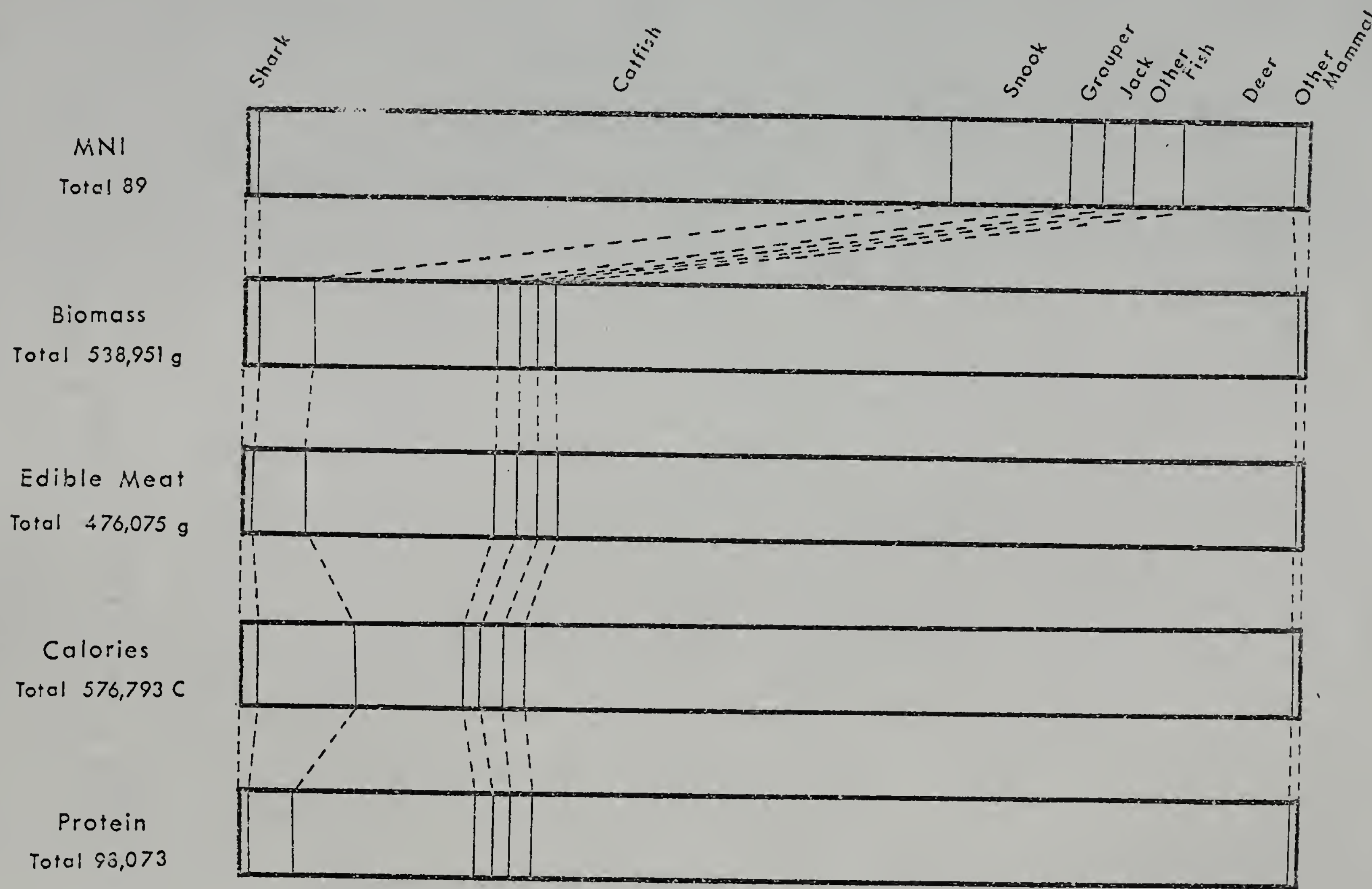


Fig. 10

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES

Valdivia

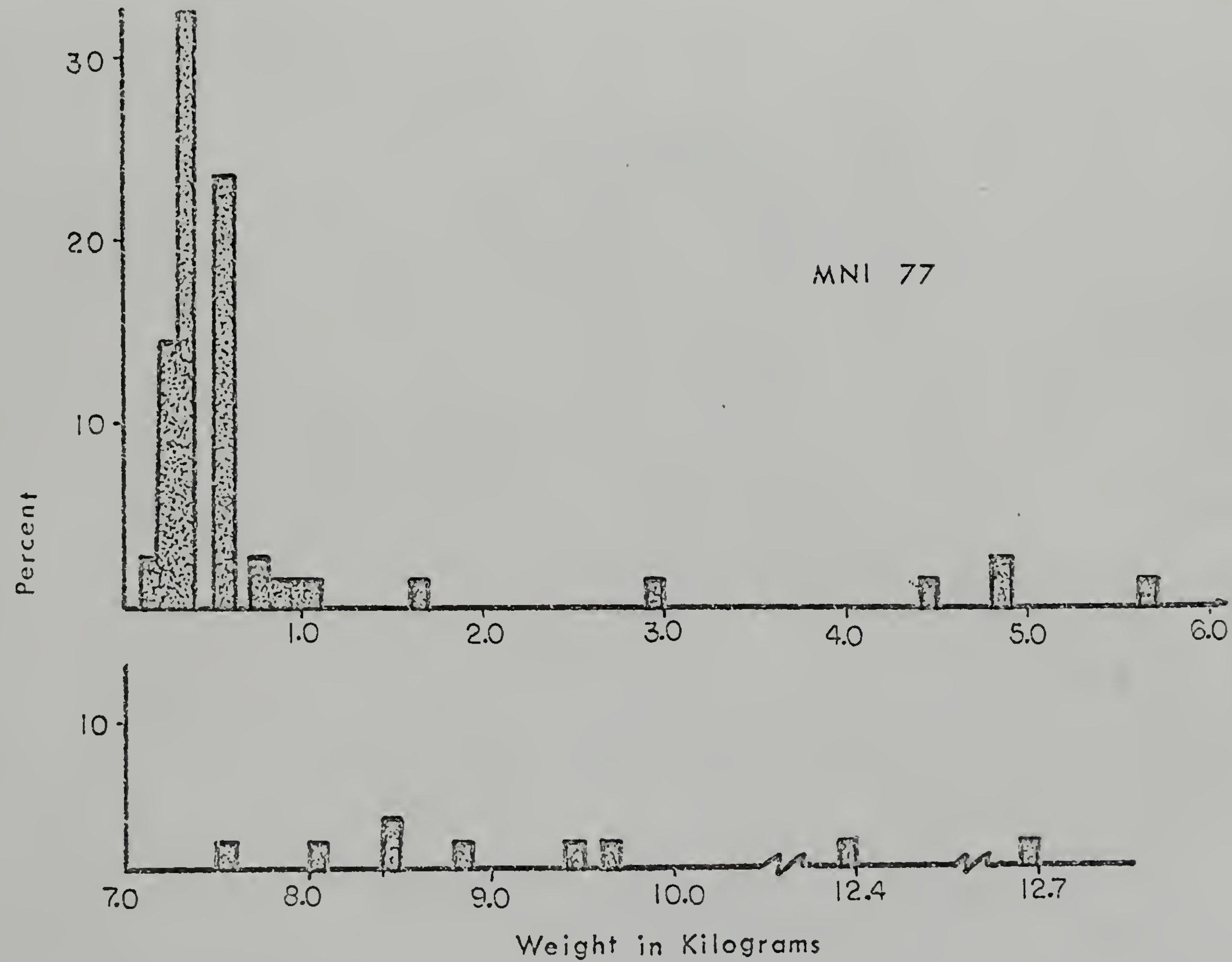


Fig. 11

DISTRIBUTION OF WEIGHT OF CAPTURED FISH

Valdivia

Reconstructed hunting and fishing patterns. The technique used to obtain the terrestrial forms is difficult to determine. As yet no stone or bone projectile points have been uncovered in Valdivia middens. Perishable wooden projectiles or traps and deathfalls are techniques that could have been used.

All the fish species from the Valdivia midden sample are inshore carnivores and will take a hook. No herbivorous forms are included in the remains. If herbivorous forms had been present in numbers, another or additional method of fishing, e.g. cooperative netting, might have been suggested. The fish bones from this site, then, present a picture of individual fishermen exploiting the inshore or shoreline waters with baited hooks and lines. Further evidence for this is the shell fishhooks that have been found at Valdivia. Although boats could have been used, there is no evidence to suggest that they would have been needed to obtain the fishes present.

One difference in this site, compared with other sites, is the proportionally greater representation of large fish, particularly snook, and the low numbers of smaller animals. The lack of smaller species is probably in part due to the excavation techniques used. The relatively large representation of snook, undoubtedly, results from fishing the estuary that is believed to have existed near the site during Valdivia times (Meggers, Evans, and Estrada 1965). This sort of ecological setting would have been particularly attractive to the snook.

Inland Sites

Zooarchaeological materials from two, inland Valdivia sites were available for analysis, the Loma Alta site, located about 15 km. upstream from the Valdivia site, and the Real Alto site situation about 5 km.

from the sea along the Rio Verde. Loma Alta representa an early Valdivia site (Phase I) while the principal occupation at Real Alto occurred from Valdivia III through VIII times (Marcos 1975). In an attempt to study change through time this latter site was divided into two groups, a middle Valdivia component represented by III-V ceramics and a later Valdivia indicated by VI-VIII ceramic types.

Excavations at Loma Alta and Real Alto revealed a discontinuous distribution of faunal material in pits, burials and house structures, which necessitated a different approach to the material. Since there was no way of knowing how many pits were associated with any particular house floor, it was impossible to provide any kind of meaningful combination of features and, therefore, the units were treated individually.

Loma Alta

The Loma Alta site contains a wider variety of vertebrates than any other site considered in this study. Representatives of all the vertebrate classes are present. This indicates a wide subsistence base. No doubt some of this results from the location of the site in a presumed forested area, although other factors also are evident. The types and numbers of the remains were not evenly distributed throughout the site. The JII unit has more catfish, while JIII contained more deer (Fig. 12)

Faunal remains. Not all the remains from the Loma Alta site constituted food items. The large number of human bones in the sample suggest that at least some of these bones represent burials rather than food remains. The dog also may represent something other than, or in addition to, a food item. The dogs could have served a variety of functions

either as guard dogs, hunting dogs, camp scavengers or pets. The burned condition of some of the bones suggest that the dog also ended up as food.

At Loma Alta the two samples analyzed contained the same principal animals, but in very different proportions. Since there was no way of determining which sample was more representative of the site as a whole, it was felt that no biomass estimates should be attempted. However, the size of the species present, and their relative numbers, suggest that terrestrial forms, especially the deer, were the principal protein sources. The Valdivia hunters obtained both principally forest-edge and/or savanna animals such as the white-tailed deer, agouti, and rabbit and presumably deep forest inhabitants, the brocket deer and the tapir. Peccary, opossum, and the carnivores, the mountain lion and the fox were also hunted. Several small rodents, and an armadillo represent other mammals captured. The Valdivians at Loma Alta also caught birds, as the considerable number of bird remains from the site indicates. Additional animals include snake, land turtle, and frog.

Of particular interest, though of seemingly minor importance, are the fish remains from Loma Alta. All the fish species represented in the midden are of marine forms. It is estimated that Loma Alta is 15 km. (9.3 miles) from the sea and, therefore, from the marine habitat where these fishes are found.

Reconstruction of hunting and fishing patterns. There is good evidence for the seasonal exploitation of deer. The faunal sample from Loma Alta contained nine mandible fragments representing a minimum of six deer. Based on tooth eruption (Severinghaus 1949), one individual was

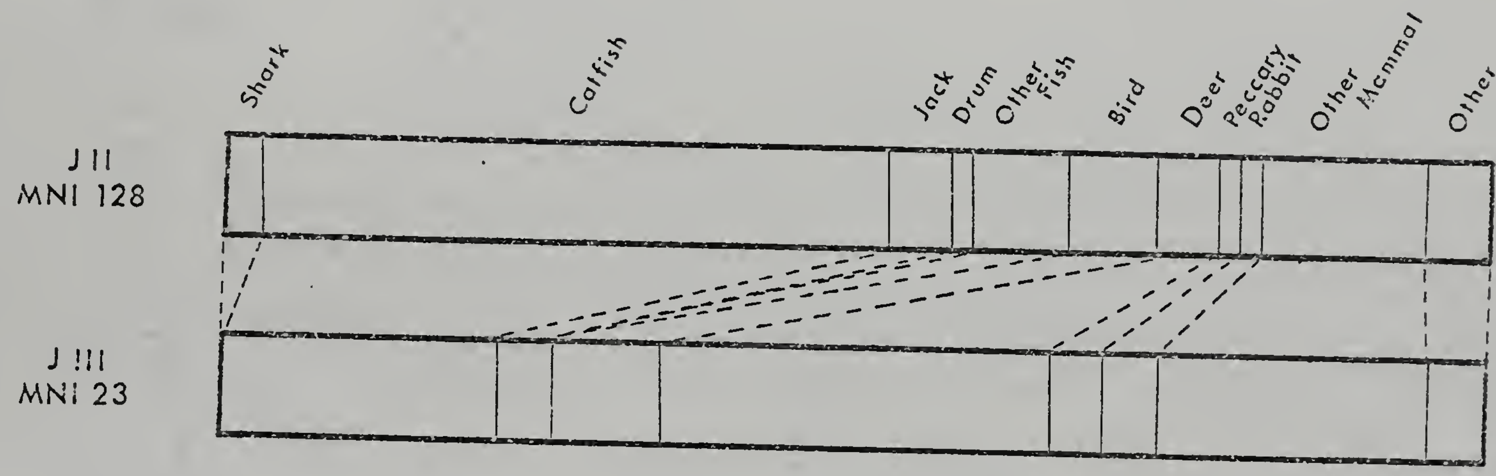


Fig. 12

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES

LOMA ALTA

between four and seven months old, two others were around 15 months, two 17 months and one was an adult. The deer that could be aged in months indicate a deer hunting season confined to about a five month period. This could be interrupted as a seasonal occupation of the site or a restricted period of exploitation of deer possibly revolving around other seasonally-regulated activities. The latter possible seems more likely. A people who seasonally moved into the area would be unlikely to engage in trade with coastal areas for their fish or to send some people out into the hills to hunt while others travel the 15 km. down to the shore to fish. Loma Alta is more likely to represent at least a semi-sedentary village engaged in an exchange system with coastal groups for marine resources, perhaps with the Valdivia site itself.

Exchange systems are complex sets of social obligations and reciprocal arrangements which need some impetus for development. They generally develop because of the need for scarce and desired resources. Could protein scarcity have acted as the impetus for the establishment of trade with the coastal areas? Although it is not possible to say with any certainty whether this was the case, possible evidence for this exists. Among the faunal remains from the Loma Alta site there were a large proportion of human bones, especially of fetal or infant individuals. A total sample of four fetuses or infants, representing in age seven months, seven and a half months and mid-ninth month for the fetuses and a baby within its first year (Maples 1974), were found in the faunal samples. Could this large and disproportionate number of fetuses and infant remains indicate low nutritional levels resulting

in spontaneous abortions (Mulinski 1976) or infanticide which is common in many protein poor areas such as the Amazon? Could trade for fish with the coastal sites be an attempt to obtain more animal protein?

Real Alto

Real Alto is the last Valdivia site considered here. Donald Lathrap, director of the excavation at the site, states that its location indicates a river valley rather than marine focus. He believes that Real Alto represents an agricultural village based on maize cultivation (Lathrap 1975).

Because of the long occupation at Real Alto and the cultural shifts that are evident between middle and later Valdivia times, the material from this site was separated into two groups. Not all the material from Real Alto was analyzed but only a sample from certain features. These units were chosen because of their phase affiliations, size of the samples and lack of obvious evidence of intrusion. Materials from five different units were considered for the earlier cultural division. Two of these were materials from the floors of structures (Structures VII and X), two were from features (Features 10 and 171), and one was from the fill of a burial pit (Burial LI).

Faunal remains. The bone from the various units were identified and the relative numbers of the various species computed. The results of the MNI compilations are indicated on Fig. 13 and Fig. 14. The samples exhibit considerable variation. In most instances, in Middle Valdivia times, catfish represented the main component of the sample in terms of MNI with the drums the most numerous species represented in one

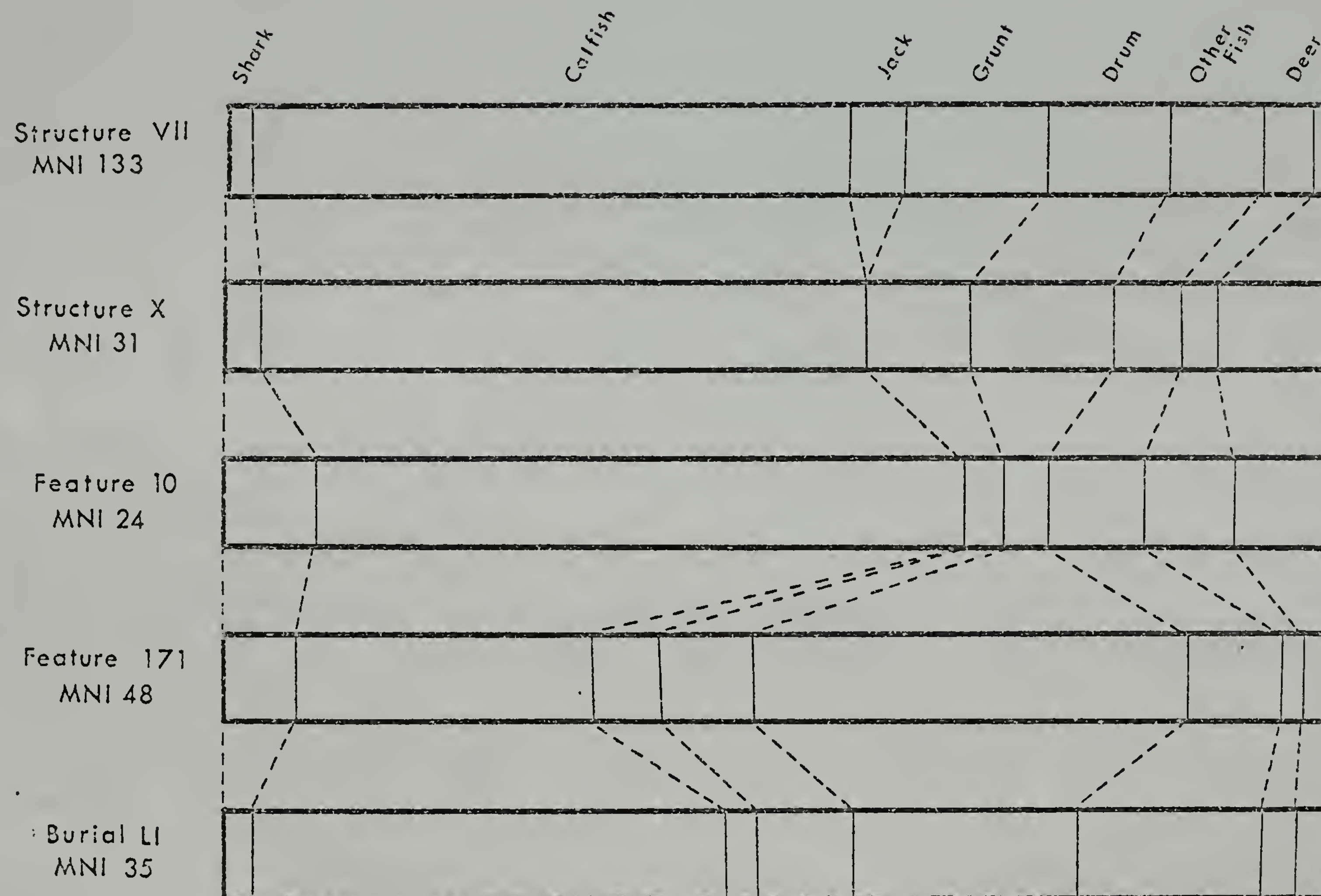


Fig. 13

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
REAL ALTO
(middle)

sample. Drum is also of considerable importance in several of the other samples as well. Deer are present in all the units and birds and sea turtles and an occasional snake also occur.

Because of the uneven distribution of the faunal remains in the numerous pits, occupation floors, wall trenches and burials at the site, biomass estimates were not attempted. There was no way of determining which and how many pits were contemporaneous with each house floor or even the initial volumes of the various features. Since there was not any means of correlating pits and floors and other features, it was felt that any biomass estimates would result in an erroneous representation and indicate a greater accuracy than the material warranted. Although biomass estimates were not undertaken for this site, deer undoubtedly represents the most important, single food source in terms of the amount of meat provided. Fish, however, especially the marine catfish, provide a more constant food source.

When the material from Middle Valdivia samples is compared with later Valdivia material a shift in emphasis becomes apparent. Material from the Structure VIII wall trench, Features 101 and 108 and general non-feature midden material indicates a greater exploitation of catfish in later Valdivia times (Fig. 14).

Reconstruction of hunting and fishing patterns. As in the case of Loma Alta the question of trade or specialized hunting and/or fishing arises. It could be argued that if Real Alto like Loma Alta was primarily an agricultural village most of its daily activities would be related to agricultural pursuits. Fish could be obtained by exchange. It should be noted, however, that 5 km is not a very great distance to go

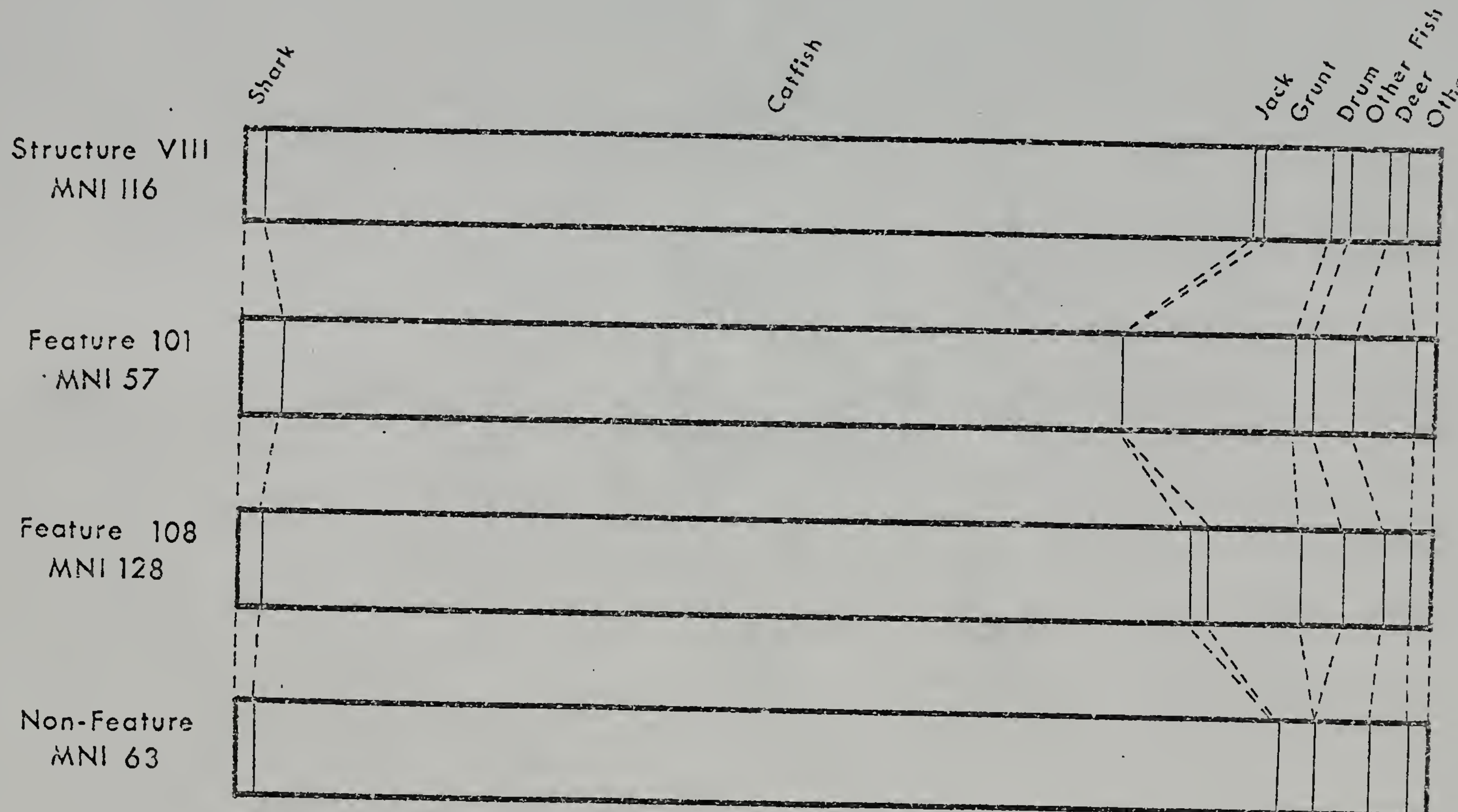


Fig. 14

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES

REAL ALTO

(late)

to obtain food. This is at the outer limits, but within the range indicated by E. S. Higgs and C. Vita-Finzi (1972) as the exploitable distance for horticulturalists. Also, it would be possible for the village to have specialized fishermen who could exchange parts of their catch for agricultural goods. Real Alto's nearness to the coast does not seem to result in the same sorts of pressures discernable at Loma Alta. Whether exchanged between villages, obtained by specialists, or caught by the Valdivia horticulturalist, fishing techniques similar to those practiced by the coastal fishermen were presumable used. These would include baited hooks and lines for the carnivorous, inshore fishes found at this site. There are again some herbivorous remains in the sample (mullet and sea chub), but their numbers are very low and do not necessarily suggest nets or traps.

Post-Valdivia

Material from only four post-Valdivia samples was available for analysis. These samples included remains from four cultural phases; Machalilla and Engoroy bones, Guangala phase material and the late Libertad remains. Three of the samples are from the Santa Elena Peninsula, the fourth is from the Rio Verde Valley.

Machalilla and Engoroy Phases

OCSE-46D

This site contains both Machalilla and Engoroy phase material, but very small samples of each. In addition, a larger sample from this site was also included, but had a mixed Machalilla and Engoroy association. The material from this site was, therefore, treated in three units;

Machalilla material, Engoroy remains, and all the bone from the site together . Biomass estimates, fish species size and nutritional values were calculated for the site as a whole (Fig. 15). The faunal lists for each unit are in Appendix A.

The Machalilla Phase represents an introduction of some new traits into the study area. Some researchers see the introduction of a new people, in part, contemporaneous with the Valdivia Phase inhabitants. They believe that Machalilla represents a site-unit intrusion into the area and that the Machalillans lived more or less harmoniously with their Valdivia neighbors (Meggers, Evans, and Estrada 1965). Other archaeologists feel that the Machalilla people lived later than the Valdivians and in fact developed out of the earlier Valdivia Phase (Lathrap 1967; Wiley 1971).

Faunal remains. The Machalilla fish remains from OGSE-46D do not differ in type from those of other Santa Elena Peninsula sites, although some different species are represented. Catfish are still the most abundant species. Other species, not found in previously discussed Santa Elena Peninsula sites, include the dog and the agouti.

The Engoroy material, sometimes included under the Chorrera Phase heading, represents the only late Formative material available for analysis. The Chorrera Phase is stated to have evolved out of the Earlier Machalilla and to represent a subsistence shift from sea food resources to agricultural crops (Willey 1971). Fairly good evidence for contact with Mesoamerica is also available for this phase (Meggers 1966).

Although some sites of Engoroy-Chorrera affiliation might indicate a decreasing importance in marine foods, this does not seem to be the case with the Engoroy inhabitants at OGSE-46D. At this site marine

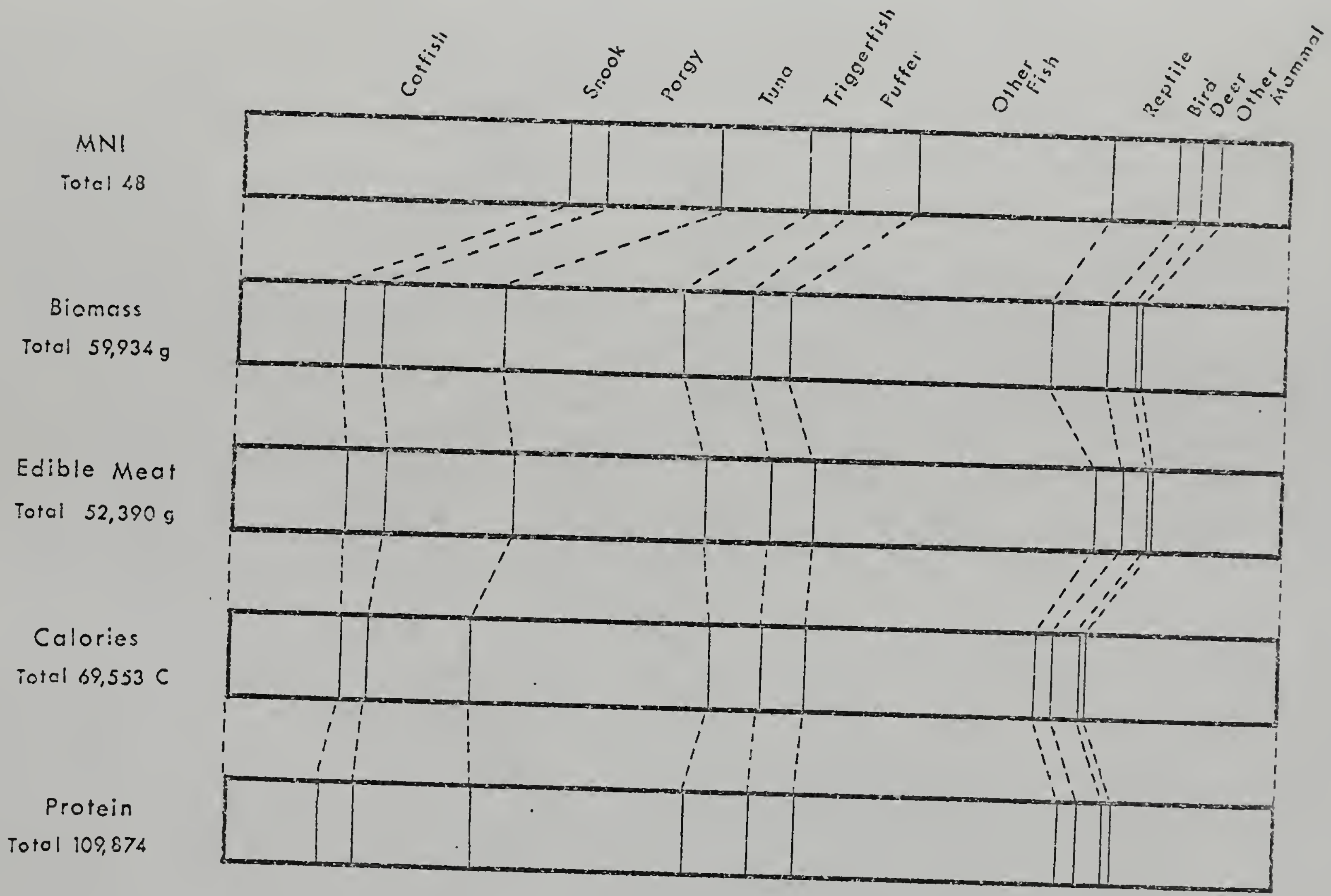


Fig. 15

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
OGSE-46D

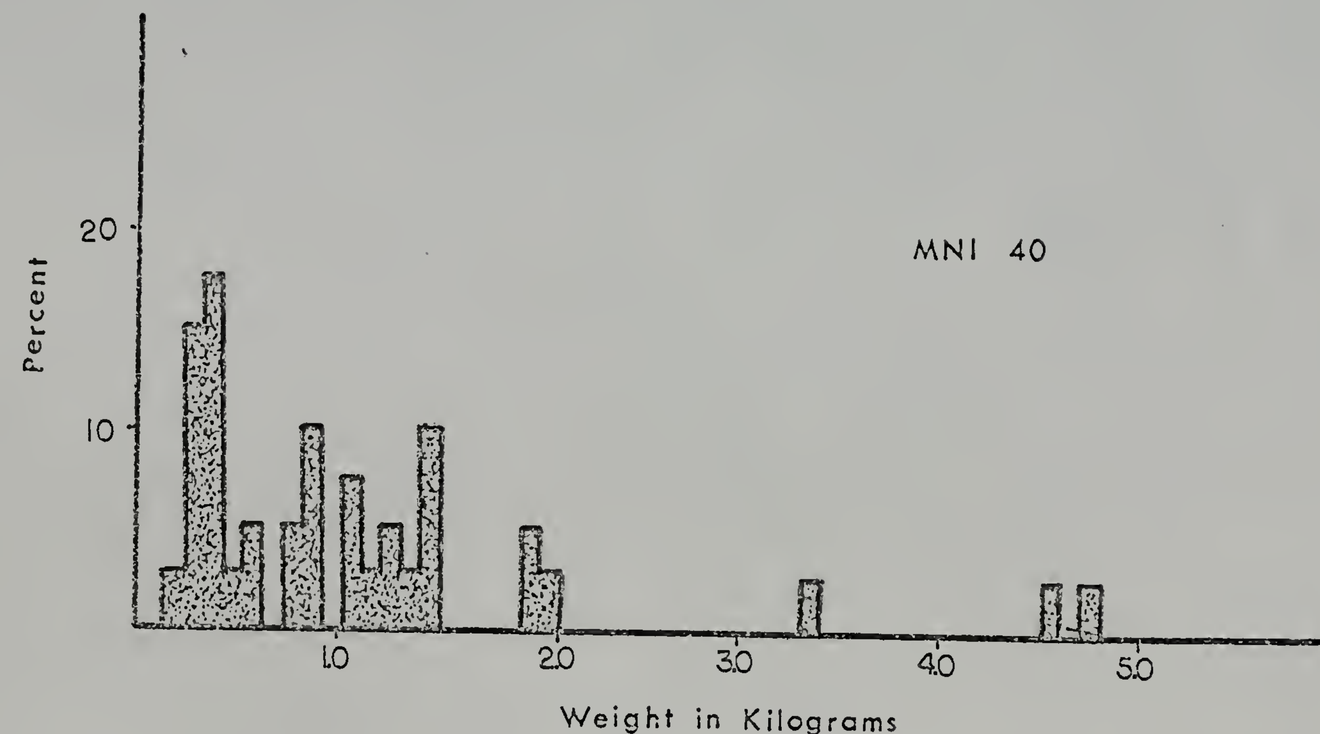


Fig. 16

DISTRIBUTION OF WEIGHT OF CAPTURED FISH

OGSE – 46 D

vertebrates continued to be widely exploited. The remains indicate that a wider variety of species were exploited by the Engoroy than by the earlier Machalilla people. Terrestrial deer and fox were also taken. Again there is evidence of dog.

Because of the small size of the Machalilla and Engoroy samples and their basic similarities with respect to the types of species present and their relative numbers, the material from these two samples were combined with the other faunal remains from OGSE-46D. Figures 15 and 16 represent these combinations. The results of the calculations indicate that marine resources were of primary importance both numerically and nutritionally. Although the deer estimates in this set of calculations was based on bone weight and is, therefore very low, the small number of deer bones and the abundance of aquatic resources suggest that deer was probably not overly important in the diet. Most of the primary species exploited by these peoples were those also utilized by previous groups. In general, the size of the fish captured appears to have increased compared with previously discussed Santa Elena Peninsula sites (Fig. 16). This might have resulted from the introduction of larger fishhooks during Machalilla times.

OGCH-20

The other Machalilla site considered in this study is OGCH-20. It is located on the Rio Verde, about five kilometers upstream from Chanduy. This site is of interest since it represents an inland Machalilla occupation, one that is in the same vicinity as Real Alto, the middle and late inland Valdivia site discussed above. The people at the site presumably utilized the Rio Verde valley in the same manner as the Valdivian, i.e. by cultivating crops.

Faunal remains. The faunal sample from the site differs from the Real Alto material in having an additional mammal, the fox. This exploitation of mammals other than deer was also evident at the coastal OGSE-46D site. This differs from the general Valdivia exploitation pattern. The Valdivians, when they exploited any mammals at all, relied on deer. The other faunal remains included large numbers of fish. As in most cases considered in this study, marine catfish was by far the most abundant fish. Also of importance were the drums and to a lesser extent the grunts.

Guangala Phase

The Guangala Phase represents the local manifestation of the Regional Developmental Period. Characteristics of this period include "... differentiation in sociopolitical organization, florescence in art style and elaboration in technology" (Meggers 1966:67).

At Guangala sites maize agriculture appears to be widespread as the presence of _mano_ and _metate_ fragments indicate. Interior incised pottery bowls suggest that manioc or peppers were also grown (Meggers 1966). Marine resources continued to be utilized by coastal groups, while deer were hunted in the inland sites (Meggers 1966). Shell fishhooks and atlatl hooks have been found in the middens.

OGSE-46U

Faunal remains. The Guangala faunal material from this site shows a pronounced marine focus. All the identifiable remains are of marine fishes. Particularly abundant in the midden are the marine catfish, although grunts and puffers are also numerous. In terms of actual

nutritional and caloric values, the single shark from the midden appears of primary importance. There is no doubt that these Guangalans made much more use of the available marine vertebrates than the earlier Machalilla and Engoroy peoples who had settled in about the same area.

Libertad Phase

The last site representative of the post-Valdivia vertebrate exploitation on the Santa Elena Peninsula is a very small sample from a Libertad Phase site, OGSE-41E.

OGSE-41E

Faunal remains. This site is located near the sea and represents a single phase occupation. The small test conducted into this midden resulted in very few bones. The sample is again mainly fishes, with grunts the most abundant form. With the exception of a small barracuda all the species present had been found in other Santa Elena Peninsula sites. Of the very small sample only one bone could be tentatively identified as mammal, all other identifiable bones were of fish (Fig. 17).

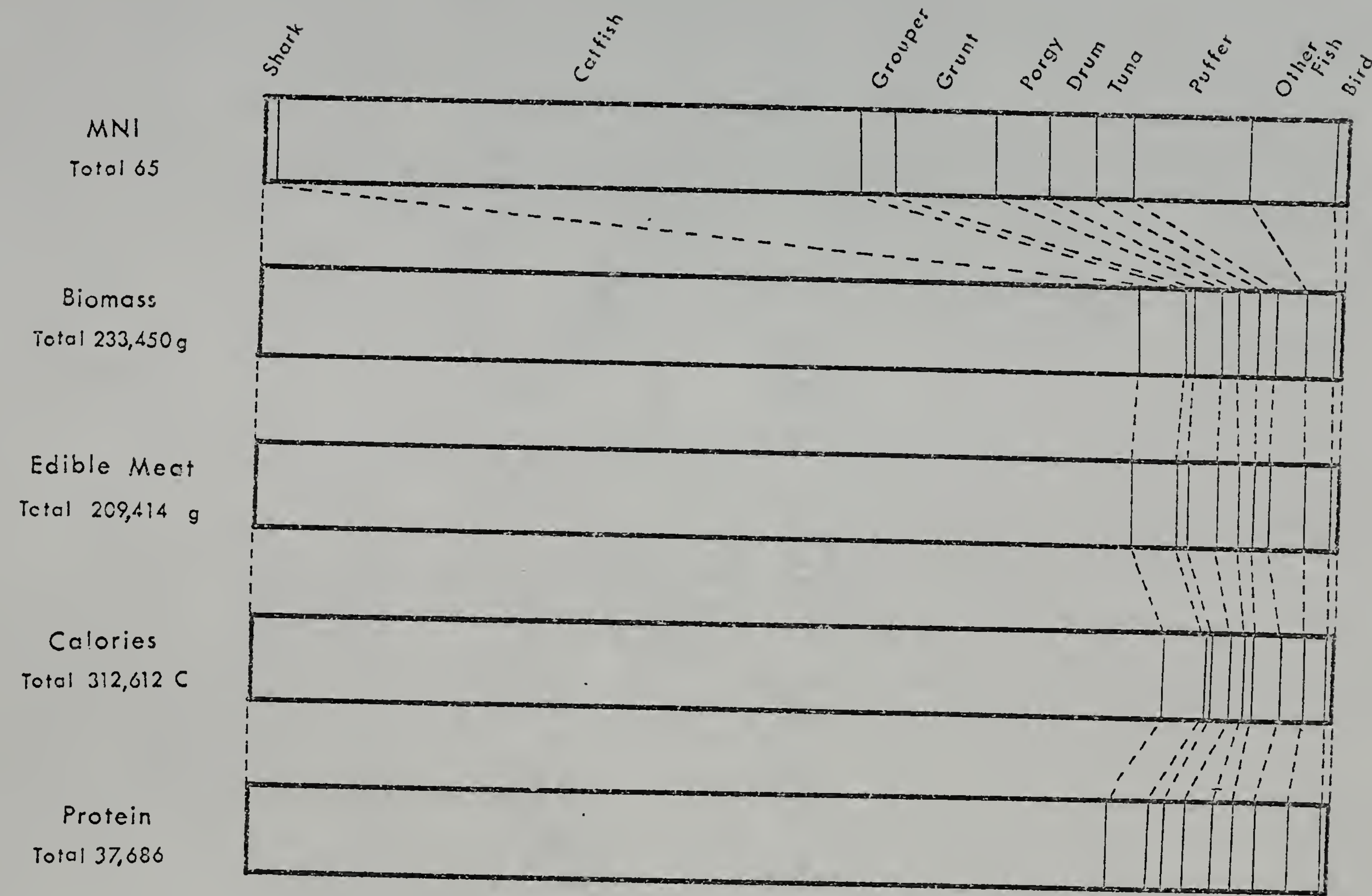


Fig. 17

RELATIVE PERCENT OF PRINCIPAL VERTEBRATES
OGSE-46U

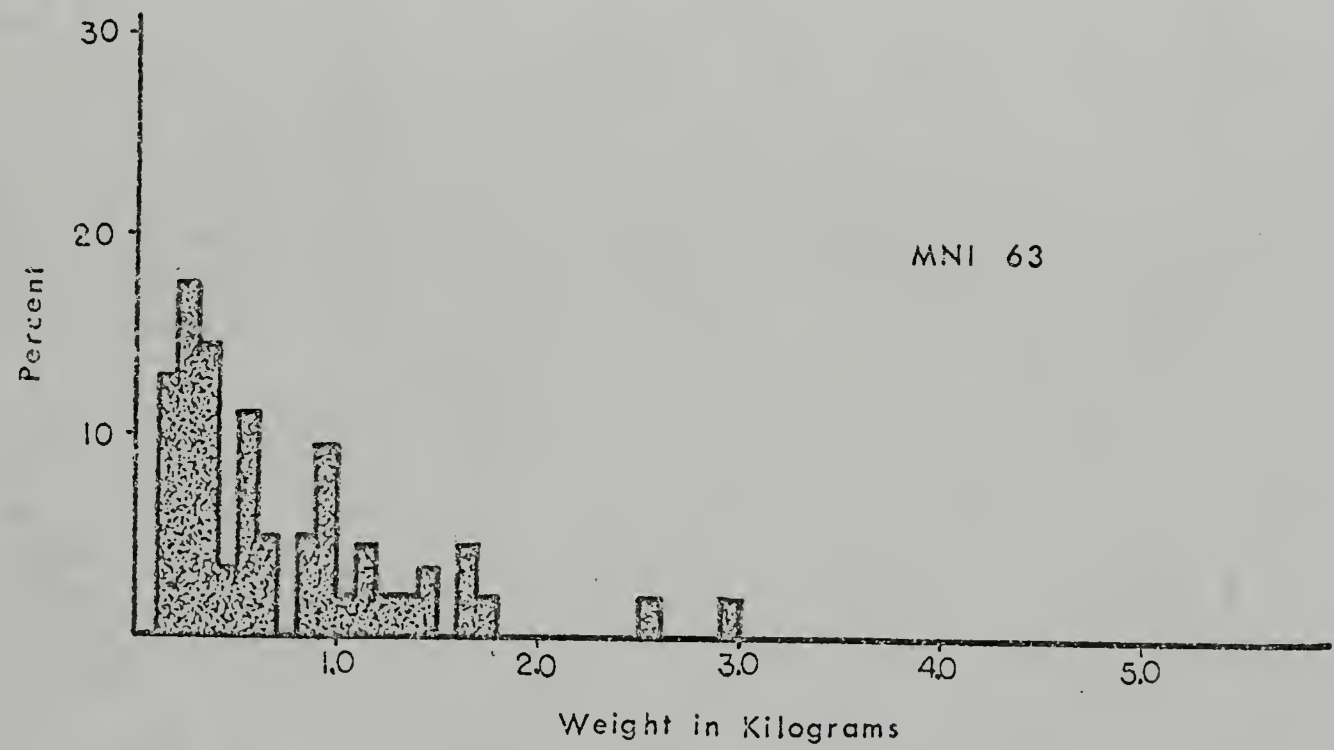


Fig. 18

DISTRIBUTION OF WEIGHT OF CAPTURED FISH

OGSE – 46 U

CHAPTER VI
DISCUSSION

Over a period of seven or eight thousand years the southwestern coast of Ecuador has served as the home for numerous peoples. Some of these groups were simple hunters and gatherers, while others were advanced agriculturalists with well developed ceramics and art styles. Although these populations differed radically in many aspects of their cultures, they all faced the same basic problem - how to obtain adequate amounts of protein, fats, carbohydrates, vitamins, minerals, and calories. To fulfill these basic needs these peoples relied upon a variety of different foods. The relative importance of the various foods differed from group to group.

Protein Scarcity and Protein Acquisition

A variety of different subsistence strategies can be practiced by peoples to obtain adequate protein for healthy growth and development (See Chapter II). These strategies include the consumption of large quantities of protein-rich plant foods, the consumption of complimentary plant foods, or the consumption of a combination of plant and animal foods.

Although these strategies are all possible alternatives in most areas, in any given area one strategy is more efficient in fulfilling nutritional and caloric needs. Animal bone was present at all the sites examined in this study. This indicates that the subsistence strategy chosen by these groups included the consumption of animal foods.

In areas where protein is abundant, protein acquisition may have little direct effect on the culture, but where it is limited the obtaining of protein can greatly influence other aspects of culture. In such cases the need for protein may result in the dispersal of the population (Holmberg 1969, Carneiro 1973), increase hostilities between groups competing over the same limited resource, development of reciprocal relations between members within the villages (Gross 1975), or lead to the formation of long distance exchange networks.

Archaeologically, the degree to which a people were obtaining adequate amounts of protein, can be reflected in the human osteological remains. Protein deficiency can limit population growth by increasing the incidence of miscarriages, spontaneous abortions, and high infant mortality (Mulinski 1976). It may further result in the adoption of population-regulating mechanisms such as female infanticide. Even for those individuals who survive to maturity, protein deficiency can effect the overall growth and stature of the individual. By examining the human bone remains from a site some indication of how successful a people were in obtaining protein can be determined.

The indicators of protein deficiency may not be readily recognized by the field excavator. Studies on human growth and stature require knowledge of human osteology and a familiarity with different growth patterns. Also, human fetal and infant bones are very different from adult bone and can be easily missed by excavators not trained in human osteology. Unless a physical anthropologist is present during excavation and removes the fetal and infant bones from the sample, the lack of fetal and infant remains in a faunal sample probably means there were few at the site. Their presence in large numbers in the faunal remains suggests nutritional stress.

At the Valdivia period, Loma Alta site a proportionally large number of human fetal and infant remains were uncovered (Chapter V). This is interpreted as an indication that these inland people were living under conditions of protein stress. In an apparent attempt to overcome this deficiency the inland Loma Alta people tried to obtain additional protein by utilizing marine resources. They did this by acquiring fish from the coast, probably by means of exchange.

This type of exchange between inland and coastal peoples has been noted in other areas. The exchange between valley and coastal sites was evident as early as Period 7 (2500-1700 B.C.) in coastal Peru (MacNeish et al 1975). During this period Richard MacNeish believes that the coastal fishermen "... sent marine protein foods into the valley and received cultivated plant foods in return" (MacNeish et al 1975:33).

None of the other sites considered in this study exhibited the same high proprotion of human fetal and infant remains as was present at Loma Alta. This could indicate that protein deficiency was not a problem at these sites. Their location near the protein-rich coastal waters is probably responsible for this.

Changes in Protein Exploitation and Subsistence Orientation

The relative importance of terrestrial, as opposed to aquatic resources, used by the prehistoric peoples of the study area varied. During some cultural phases, terrestrial resources were more important, while at others aquatic animals were more significant in the diet.

These changing patterns of protein exploitation and subsistence are summarized in Tables 2 and 3. The relative minimum number of individuals of terrestrial and aquatic animals represented in samples from

TABLE 2
PERCENTAGE OF FOODS FROM AQUATIC AND
TERRESTRIAL HABITATS - MNI

	Santa Elena Peninsula						
	Pre-Valdivia		Valdivia			Post-Valdivia	
	OGSE-80	OGSE-63	OGSE-174	OGSE-62	OGSE-62C	OGSE-46D	OGSE-46U
aquatic %	55	75	82	99	99	87	98
terrestrial %	45	25	18	1	1	13	2
sample size	56	12	17	86	88	48	66

	North of the Santa Elena P.			East of the Santa Elena P.		
	Valdivia			Valdivia		Post-Valdivia
	Coast Valdivia	Inland Loma Alta		Real Alto		OGCH20
		J11	J111	Early St. VII	Late St. VIII	
aquatic %	88	69	26	95	97	96.8
terrestrial %	12	31	74	5	3	3.2
sample size	89	133	23	133	116	281.0

the principal sites considered in this study are presented in Table 2. This first set of calculations indicates how intensively the vertebrates from the two exploitation areas were utilized by the various cultural groups. The second table (Table 3) illustrates the amount of meat obtained from these two sources.

Estimates of the weight of the aquatic and terrestrial forms were based on the weight of the archaeological bone. The bone weight was used in the formulas in place of the skeletal weight and the formulas for skeletal weight to live weight from Appendix C was used. The perciform fish formula was employed to estimate aquatic resources, the mammal formula was used for the terrestrial animals. The only site for which estimates of live weight were not computed in this manner was the Valdivia site. The bones from this site were partially mineralized, so weight calculations would be extremely inaccurate. For this site, the estimates calculated in Chapter V were used.

The data presented in Tables 2 and 3 illustrates a steady shift in subsistence orientation on the Santa Elena Peninsula. Early cultural groups relied more on terrestrial animals, while the Valdivia peoples depended more on aquatic forms. The early post-Valdivia people again hunter terrestrial animals, but later groups shifted back to almost exclusive aquatic exploitation.

The inland and northern sites show a somewhat different orientation. At these Valdivia sites terrestrial resources are more numerous and provide far more meat than aquatic vertebrates. Even at these sites aquatic resources were widely exploited.

Several factors could be responsible for the changing subsistence patterns described here. These include the introduction of agriculture

TABLE 3
PERCENTAGE OF FOODS FROM AQUATIC AND TERRESTRIAL HABITATS - BIOMASS

	Santa Elena Peninsula						
	Pre-Valdivia		Valdivia			Post-Valdivia	
	OGSE-80	OGSE-63	OGSE-174	OGSE-62	OGSE-62C	OGSE-46D	OGSE-46U
aquatic %	5	10	24	99	99.7	95	99.7
terrestrial %	95	90	76	1	0.3	5	0.3
total biomass (g)	21300	8435	9007	7955	9124	12372	5273

	North of the Santa Elena P.		
	Valdivia		
	Coast Valdivia	Inland Loma Alta	
		J11	J111
aquatic%	29	9	16
terrestrial %	71	91	84
total bio mass (g)	538951	68915	54633

	East of the Santa Elena P.		
	Valdivia		Post-Valdivia
	Inland Real Alto		OGCH-20
	St.VII	St VIII	
aquatic%	21	15	17
terrestrial %	79	85	83
total bio mass (g)	36567	22013	

and the changing climatic conditions. I propose that the change in emphasis between pre-Valdivia and Valdivia times is linked to another subsistence shift, probably the introduction of agriculture.

Although there is little direct evidence of agriculture, indirect evidence such as storage pits, grinding implements and the locations of the sites indicates that agriculture had been introduced into the area and was being practiced during Valdivia times. Crops, e.g. corn, require periods of fairly intensive cultivation and care. During these periods there is less time to devote to other subsistence activities such as hunting and fishing. This often results in the scheduling of subsistence activities with certain periods of time devoted to one strategy, i.e. the cultivation of agricultural crops, and other times devoted to other pursuits. This scheduling can take the form of gardening at one time during the day and hunting and/or fishing at another or a seasonal cycle of cultivation supplemented by limited hunting and/or fishing in areas near the village at one period of the year with extensive hunting and fishing more prevalent in another season.

There is evidence of scheduling from one Valdivia site. At Loma Alta all the deer that could be aged indicate that they probably were killed during a particular time of year. This suggests that deer hunting was more or less restricted to a particular season.

Although there has been little research conducted on the breeding cycles of deer in coastal Ecuador, studies on the white-tailed deer from Venezuala indicate that these species breed year round with a peak in mating during the dry season (Brokx 1972). The gestation period for North American white-tailed deer is between 195 and 212 days, with an average around 202 days (Lowery 1974). If the Ecuadorian deer follow

the same cycle, the peak mating would be between May and December, the dry season of present-day coastal Ecuador. This would result in peak births between October and July. Since the survival rate of the fawns would be greatest for those born during rainy season, when the lactating does have abundant food resources, the peak in birth and survival of most fawns would be expected from January through April. If Janaury is assumed to be the birth month of the deer at the Loma Alta site, the individuals that could be aged were killed anywhere from April to September (Fig. 19). At the other extreme, if they were born at the end of the rainy season (April) the range would be from July to December.

The onset of the rainy season is also a time of peak agricultural activities. During this period presumably little time would be available to engage in substantial hunting endeavors. Instead, more time would be spent in the planting, cultivating and harvesting of the crops. The length of this period of agricultural activity is largely dependent on the crops planted. For corn, anywhere from three to four months would be devoted to the cultivation and harvesting of this crop. If the crop was planted at the onset of the rainy season, January through April would be devoted to its cultivation.

When the deer hunting season, as indicated from the Loma Alta material, is compared with the period of corn cultivation a yearly scheduling of economic activities is suggested. The data on Fig. 19 illustrate this. Agricultural activities, i.e. corn cultivation, would be restricted to the rainy season of January through April with deer hunting practiced anywhere from April through December.

In addition to the scheduling of economic activities, the introduction of agriculture can also result in the expansion of the possible

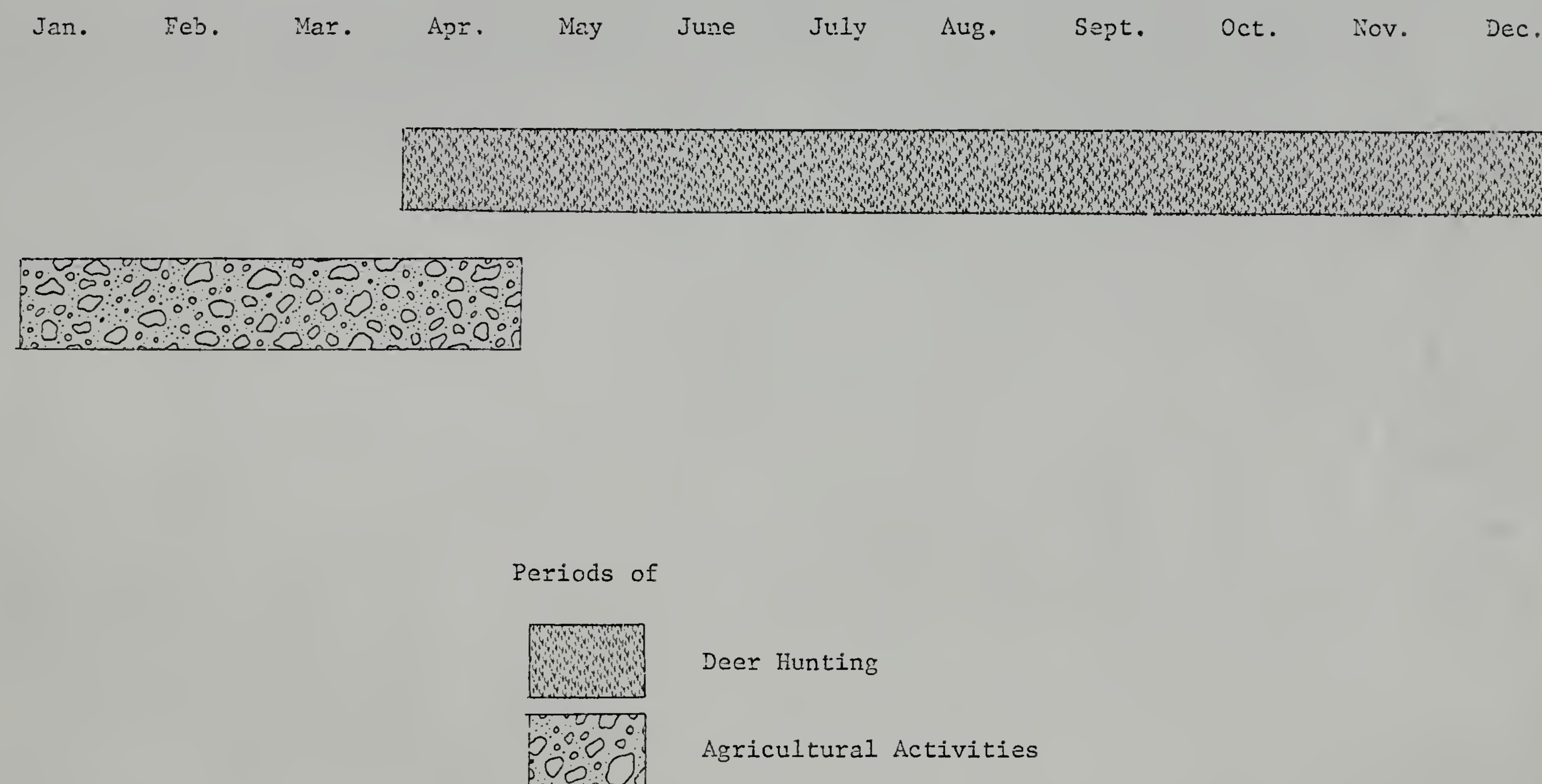


FIG. 16

AGRICULTURAL AND DEER HUNTING SEASONALITY

subsistence base with the introduction of new crops and an increase in population size resulting in the shrinkage of the territory exploited by the inhabitants of a site. This has been seen ethnographically when the radius of the exploitation spheres of the hunters and gatherers (10 km.) is compared to the area exploited by horticulturalists (radius 5 km.) (Higgs and Vita-Finzi 1972). This decrease in exploitation area results in proportionately less terrestrial animals available to hunt. It would encourage a shift to other protein foods. In the study area I believe this to have taken the form of increased use of the previously, underexploited, aquatic vertebrates.

Another possible factor which may explain the shift in subsistence patterns is climatic change. The Santa Elena Peninsula is and has been an area that is particularly susceptible to climatic fluctuation (Chapter IV). In the past there have been several periods much wetter or dryer than today. Because of the close relationship between climate, flora, and fauna, a shift in climatic conditions can profoundly alter the resources available for exploitation. This necessitates the use of alternative methods of exploitation, a change to different resources, or an abandonment of the area.

During periods of extreme wetness or dryness the Santa Elena Peninsula was uninhabited (Chapter IV). Presumably under these environmental conditions, the people were either unwilling or unable to make the adjustments necessary in order to continue living in the area. During times of minor climatic change extreme action such as the abandonment of the area might not be necessary. During these periods, by exploiting a slightly different subsistence base, a people could continue to live in an area.

As noted in Chapter IV, the Machalilla and Engoroy peoples occupied the peninsula during times of fluctuating climatic conditions. Immediately previous to Machalilla occupation the climate of the Santa Elena Peninsula was very cold and dry. During Machalilla times it became somewhat warmer, but still remained cool and relatively dry. Cold and very dry conditions existed between the Machalilla and Engoroy occupations and the climate was cool and dry again in Engoroy times.

As illustrated above (Chapter V) the Machalilla and Engoroy groups, considered here, exploited a slightly different subsistence base than previous groups. I would suggest that this exploitation pattern results from slightly different climatic conditions and, therefore, different species availability and densities.

It might be argued that the introduction of a new people, who utilized a different resource base, is responsible for the different subsistence pattern reflected in the bone remains. I believe that, since the same resource configuration is present during both the Machalilla and the later Engoroy times, the migration of new people with a different exploitation pattern cannot be used to explain these difference.

Hunting and Fishing Methods

How a people obtained their animal protein is another important aspect of subsistence studies. The faunal composition of a site often indicates what methods were used to obtain the fishes present. For example, if the habit and habitats of the fishes that are available in the area are known, inferences about the methods used to catch them can be made.

The coastal waters of Ecuador today contain many different types of marine fishes. Estuaries and inshore waters are inhabited by large

numbers of schooling, plankton-feeding herrings and anchovies plus smaller schools of herbivorous mullet. Also present are the carnivorous catfishes, snook, groupers, jacks, and snappers. Other estuarine and inshore fishes include the dentritus feeding mojarras and gobies, and the drums, grunts, bonefish, and porgies who feed primarily on invertebrates. Some fishes are located further out from the shore. These include the tunas, halfbeaks and flyingfishes and the dolphinfish.

Because of the different habits of these various fishes, fishing techniques efficient in obtaining one type would not necessarily be successful in catching another form. The use of weirs would result in the capture of both the schooling herbivores and the solitary carnivores. Traps are effective in catching fishes who feed on the type of bait used in the traps or those who favor close protected crevasses to hid or rest in. This last group mistakes the traps for safe resting places. Nets are more efficient on schooling species, such as herring, anchovies or mullet. Netting results in the capture of large numbers of these animals. Baited hook and line fishing selects for carnivores. Hook and line fishing can be either with a single line or with a trot line, a series of hooks set out along a line.

There is abundant evidence that carnivorous fish were widely exploited by prehistoric inhabitants considered in this study. Nevertheless, largely missing from the sites are the herbivores and schooling species, e.g. mullet, herring, anchovy, and halfbeak, which are abundant in the area today. The lack of any substantial numbers of these animals indicates that methods, such as nets, efficient in obtaining large numbers of these animals, were not used. It also appears that weirs were not employed. If weirs had been used a more balanced herbivor-carnivore

ratio could be expected in the catch. This is not represented in the middens. Because of the high percentage of carnivores and the very low number of herbivores, I propose that the principal fishing method was baited hook and line. The large number of shell fishhooks from sites of the various phases support this position.

The hunting methods are a good deal harder to reconstruct. No artifactual evidence is available to indicate which techniques were used. If rodents were in fact hunted and not incidental to the site, there is some evidence that traps were employed, especially on the rodents from the pre-Valdivia component. Since these rodents are small, nocturnal animals traps would be the most efficient way to capture them. Other methods, e.g. stalking and shooting or spearing require more time and energy. There would be little return for the energy expended in these methods. For the other animals presumably projectiles, deathfall type traps, or snares were used.

As far as can be determined there is surprisingly little change in the hunting and fishing techniques used by the various human populations to obtain their animal protein. The proportions of the various resource change, but species represented remain essentially the same.

Human Behavioral Patterns

Based on the faunal remains considered in this study, two aspects of human behavior patterns are identifiable. The first concerns selective hunting and fishing practices, the second solitary versus cooperative activities.

There is good evidence of selective hunting and fishing represented in the faunal remains from two sites. At one pre-Valdivia site a

large number of fox teety used as grave goods indicate that fox or at least fox teeth were ritual objects. Since a large number of foxes were represented at this one site and almost totally lacking at others, I believe this infers selective hunting of fox.

Some evidence is available that indicates an increase in selective fishing in the Real Alto material. The late Valdivia material from this site includes far more catfish than the middle Valdivia remains. It is impossible to determine whether this difference is due to some type of climatic shift resulting in increased availability of the catfish, to a purposeful selection by the people, or to the introduction of a new fishing technique not discernible in the remains.

With respect to solitary versus cooperative activities, I would suggest that most of the fishing was done solitarily or by very small groups of fishermen. Large numbers of fishermen exploiting the same area with baited hooks and line would result in competition over the relatively dispersed carnivorous fishes and fewer fish would be taken by the group as a whole. If the fishermen distributed themselves over a wider area, greater returns would be epxected. If cooperative net fishing had been practiced, larger numbers of the schooling species would have been caught. This, however, was apparently not done.

As a further indication of solitary practices other aspects of the culture can be considered. There is almost no evidence of any large-scale cooperative activities on the Santa Elena Peninsula. No evidence of monumental architecture or large scale irrigation works that could require cooperative efforts has been discovered. Because of its apparent sporadic and irregular nature (Chard 1950) even long distant trade does not necessarily indicate large cooperative endeavors. These

trading ventures could have been short term and have taken place as seldom as once in a lifetime.

The only possible evidence of cooperative activities is the walk-in wells or catch basin, the first of which were built in Engoroy times. Paulsen suggests that these basins were used in conjunction with some type of intensive agriculture (Paulsen 1971), presumably in response to more arid conditions. The question here is whether these basins were constructed by large numbers of people working jointly or by many small groups or single individuals working on just one section of the basin at a time. Today on the Santa Elena Peninsula numerous wells are sunk into the bottom of the catch basins. These wells are relatively shallow and no cooperative effort would be needed to maintain them. Possibly a similar technique, i.e. the excavation of wells, was practiced in the past and the present large size of the basins represent many centuries of these practices.

Interareal Comparison

When the material in this study was compared with sites farther south, certain dissimilarities became evident. Michael Edward Moseley believes that the central coast of Peru experienced three different stages in their cultural evolution during the period he examined. He (1975:19) states:

> The prehistoric populations of coastal Peru underwent a process of fundamental economic and social change between roughly 3600 and 1500 B.C. A hunting and gathering way of life was replaced by fishing and littoral collecting which in turn was displaced by irrigation agriculture.

Moseley bases his reconstruciton on site location and floral and faunal remains.

As the dates indicate, Moseley's materials is roughly contemporaneous with the Valdivia Culture of southwest Ecuador. The Valdivia Culture, however, does not exhibit the same type of development. Whereas the (c. 3600 B.C.), coastal inhabitants of Peru relied primarily on the sea for their animal protein, the early Valdivians exploited both aquatic and terrestrial resources, and, if Lathrap is correct, practiced agriculture.

Even when compared with the earlier Vegas peoples, whose primarily hunting and gathering way of life was similar in this respect to Moseley's Lithic Stage, the exploitation focus of the two groups was quite different. The principal protein source for the Vegas people was terrestrial vertebrates, although aquatic forms were also exploited. The Lithic Stage Peruvian peoples predominantly utilized marine protein, primarily seal.

Presumably, agriculture increased in importance through time in southwest Ecuador as in coastal Peru. Fishing, however, continued and possibly increased in importance for the coastal Ecuador inhabitants considered in this study. Even for the more inland groups fishing remained important, although terrestrial vertebrates were the primary animal food.

As indicated above, the shifts in exploitation patterns were not the same in southwest Ecuador as they were in Peru. Several factors could be responsible for this. Probably the most important factor is the different ecological systems in the two areas. Whil the Peruvian coast is largely a desert, Ecuador is more a savanna and during segments of the prehistoric era was probably wetter than it is today. In addition, the Peruvian coast was undoubtedly more strongly influenced by the cold Peruvian current. These two, different, climate conditions

resulted in diverse resource availabilities and densities and led to alternate subsistence strategies.

Summary

The purpose of this study was to determine subsistence practices and related, human behavioral patterns for Valdivia Phase inhabitants of southwestern Ecuador. This goal was accomplished by an analysis of vertebrate faunal remains and the application of cultural, ecological research methods. A total of fifteen samples were considered, including three pre-Valdivia, eight Valdivia, and four post-Valdivia sites.

Based on the faunal remains from these sites, several conclusions can be made. First, the overall hunting and fishing emphasis changes during the 7900 years under consideration. Early peoples relied heavily upon terrestrial vertebrates. Later groups, beginning with the Valdivians exploited marine vertebrate resources more extensively. This shift in emphasis, from terrestrial to aquatic foods, appears to be roughly contemporaneous with the introduction of agriculture. Second, the remains from one site suggest that some type of exchange network existed between coastal and inland groups. This network resulted in marine fish protein being imported to one inland site. It could have been an attempt to alleviate conditions of protein scarcity. Third, there is limited evidence of seasonal exploitation of deer. Fourth, throughout the time periods considered here, fishing techniques appeared to have remained essentially the same. The very efficient fish nets used by many coastal people were never adopted by the prehistoric southwestern Ecuadorians. The baited hook and line seems

to have been the principal method used. No evidence of communial fishing is evident from the faunal remains.

The results of this study indicate several productive avenues for future research. Particularly informative would be an analysis of sites further north, east, and inland. These sites would have been less affected by the shifts of the Peruvian Current and the resulting climatic changes and would probably reflect a somewhat different subsistence base.

APPENDIX A
TABLE 4
FAUNAL LIST
OCSE-80

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Carcharhinidae	1	3	0.65	1.8	0.28	0.17
Dasyatidae	1	1	0.50	1.8	0.09	0.13
TOTAL Chondrichtyes	2	4	1.15	3.6	0.38	0.30
Arius-like	4	8	2.25	7.1	0.75	0.59
Bagre panamensis	4	4	2.7	7.1	0.38	0.71
Ariidae	–	16	2.67	–	1.5	0.70
cf. Ariidae	–	3	0.25	–	0.28	0.07
Centropomus sp.	3	4	1.8	5.4	0.38	0.47
cf. Centropomus sp.	–	1	0.25	–	0.09	0.07
Serranidae	1	1	0.2	1.8	0.09	0.05
Caranx sp.	1	1	0.8	1.8	0.09	0.21
Lutjanus sp.	1	1	0.1	1.8	0.09	0.03
cf. Lutjanus sp.	3	3	0.55	5.4	0.28	0.14
Cynoscion sp.	1	1	0.35	1.8	0.09	0.09
Micropogon sp.	2	2	1.1	3.6	0.19	0.29
Odontoscion sp.	2	2	0.45	3.6	0.19	0.12
cf. Sciaenidae	1	3	0.65	1.8	0.28	0.17
Mugil sp.	1	1	0.25	1.8	0.09	0.07
Scombridae	2	5	3.45	3.6	0.47	0.91
unid. Osteichthyes verts.	–	90	23.43	–	8.47	6.17
miss.	–	35	6.60	–	3.29	1.74
TOTAL Osteichthyes	26	181	48.6	46.4	17.02	12.79
Bufonidae	1	1	0.1	1.8	0.09	0.03
Anuran	1	2	0.45	1.8	0.19	0.12
TOTAL Amphibia	2	3	0.55	3.6	0.28	0.14
Cheloniidae	1	3	10.52	1.8	0.28	2.77
Constrictor constrictor	1	17	2.8	1.8	1.6	0.74
cf. Constrictor constrictor	–	7	1.4	–	0.66	0.37
Constrictor sp.	–	15	3.75	–	1.41	0.99
Drymarchon corais	1	3	0.65	1.8	0.28	0.17
cf. Drymarchon corais	–	33	4.35	–	3.11	1.15
Drymarchon sp.	–	14	3.15	–	1.32	0.83
unid. Serpentes	–	10	2.15	–	0.94	0.57
TOTAL Reptilia	3	102	28.77	5.4	9.60	7.57
Psittacidae	1	1	3.5	1.8	0.09	0.92
unid. Aves	–	1	0.1	–	0.09	0.03
cf. Aves	–	1	0.8	–	0.09	0.21
TOTAL Aves	1	3	4.4	1.8	0.28	1.16

TALBE 4 - Continued

		MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Sylvilagus cf. brasiliensis		1	2	0.95	1.8	0.19	0.25
Cricetinae		14	40	4.95	25	3.77	1.31
unid. Rodentia		-	1	0.1	-	0.09	0.03
cf. Rodentia		-	2	0.25	-	0.19	0.07
Mustela sp.		1	3	6.5	1.8	0.28	1.71
Dusicyon cf. sechurae	teeth+	27+	122	36.3	-	11.49	9.56
	misc.	4	36	46.15	7.1	3.39	12.16
cf. Dusicyon sp.	teeth	-	20	9.02	-	1.88	2.38
	misc.	8	8		-	0.75	
Canidae*		1	6	0.6	1.8	0.56	0.16
Mazama sp.		1	6	13.6	1.8	0.56	3.58
cf. Mazama sp.		-	1	2.55	-	0.09	0.67
Cervidae		-	10	8.6	-	0.94	2.27
small Mammalia		-	1	0.4	-	0.09	0.11
large Mammalia		-	277	126.02	-	26.08	33.20
TOTAL Mammália		22(45)	535	256	39.3	50.38	67.44
unid. bone		--	234	40.11	-	22.03	10.57
TOTAL FOOD BONE		56(79)	1062	379.58	100.1	99.97	99.97
Homo sapiens		1	23	19.81			
cf. Homo sapiens		--	20	39.21			
TOTAL BONE		57(80)	1105	438.88			

+Teeth of the Dusicyon apparently used as funerary offerings - not used in calculations of percent MNI.

*Canidae other than Dusicyon.

TABLE 5
FAUNAL LIST
OGSE-38

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Arius-like	1	2	0.35	12.5	1.06	0.70
Bagre panamensis	1	1	0.65	12.5	0.53	1.30
cf. Ariidae	–	1	0.15	–	0.53	0.30
unid Siluriformes	–	3	0.50	–	1.59	1.00
Caranx sp.	1	1	2.65	12.5	0.53	5.31
Mugil sp.	1	1	1.15	12.5	0.53	2.30
Tetraodontidae	1	1	0.2	12.5	0.53	0.40
unid. Osteichthyes verts.	–	49	10.65	–	25.93	21.32
misc.	–	43	6.3	–	22.75	12.51
TOTAL Osteichthyes	5	102	22.6	62.5	53.97	45.25
Cheloniidae	1	9	8.3	12.5	4.76	16.62
TOTAL Reptilia	1	9	8.3	12.5	4.76	16.62
unid. Rodentia	1	1	0.15	12.5	0.53	0.30
Dusicyon cf. *sechurae*	1	1	0.7	12.5	0.53	1.40
cf. *Dusicyon* sp.	–	1	1.3	–	0.53	2.60
unid. Mammalia	–	28	10.0	–	14.81	20.02
TOTAL Mammalia	2	31	12.15	25.0	16.40	24.32
unid. bone	–	47	6.9	–	24.87	13.81
TOTAL FOOD BONE	8	189	49.95	100	100	100

TABLE 6
FAUNAL LIST
OGSE-63

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Arius-like	1	5	1.1	8.33	0.57	0.21
Bagre panamensis	4	4	0.3	33.3	0.46	0.06
Bagre sp.	-	1	4.25	-	0.1	0.82
Ariidae	-	2	0.25	-	0.23	0.05
Cynoscion sp.	1	1	0.8	8.33	0.1	0.15
cf. Micropogon sp.	1	1	0.1	8.33	0.1	0.02
Sciaenidae	-	2	0.25	-	0.23	0.05
Mugil sp.	1	3	0.35	8.33	0.34	0.07
unid. Osteichthyes verts.	-	73	14.4	-	8.38	2.77
misc.	-	46	16.58	-	5.28	3.19
TOTAL Osteichthyes	8	136	38.38	66.67	15.84	7.39
Cheloniidae	1	1	4.4	8.33	0.1	0.85
TOTAL Reptilia	1	1	4.4	8.33	0.1	0.85
Odocoileus virginianus	2	27	92.98	16.67	3.1	17.90
Mazama sp.	1	1	2.55	8.33	0.1	0.49
Cervidae	-	31	47.11	-	3.56	9.07
cf. Cervidae	-	9	16.4	-	1.03	3.16
unid. Mammalia	-	424	276.2	-	48.68	53.18
TOTAL Mammalia	3	487	435.24	25.0	55.91	83.80
unid. bone	-	245	41.35	-	28.13	7.96
TOTAL FOOD BONE	12	871	519.37	100	99.4	100

TABLE 7
FAUNAL LIST
OGSE-42

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Bagre panamensis	1	1	1.25	20	0.5	1.3
Ariidae	--	3	0.3	-	1.6	0.3
Centropomus sp.	1	1	0.55	20	0.5	0.6
Sciaenidae	1	1	1.2	20	0.5	1.3
unid. Osteichthyes verts.	-	31	8.75	-	16.7	9.2
misc.	-	31	2.85	-	16.7	3.0
TOTAL Osteichthyes	3	68	14.9	60	36.6	15.6
cf. Cheloniidae	1	1	0.2	20	0.5	0.2
TOTAL Reptilia	1	1	0.2	20	0.5	0.2
Mazama sp.	1	1	1.25	20	0.5	1.3
cf. *Mazama* sp.	-	1	7.25	-	0.5	7.6
Cervid	-	12	32.05	-	6.4	33.7
unid. Mammalia	-	64	36.55	-	34.4	38.4
TOTAL Mammalia	1	78	77.1	20	41.9	81.0
unid. bone	-	39	3.0	-	21.0	3.1
TOTAL FOOD BONE	5	186	95.2	100	100	99.9

TABLE 8
FAUNAL LIST
OGSE-62

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Albula vulpes	1	1	0.25	1.2	0.04	0.03
Arius-like	3	33	18.65	3.5	1.2	2.52
Bagre panamensis	31	35	60.75	36.1	1.3	8.19
Bagre cf. *panamensis*	1	18	11.4	1.2	0.7	1.54
Bagre sp.	–	17	4.05	–	0.6	0.55
cf. *Bagre*	–	6	1.15	–	0.2	0.16
Ariidae	–	42	11.65	–	1.6	1.57
Siluriformes (in part)	1	2	0.4	1.2	0.07	0.05
unid. Siluriformes	–	42	13.2	–	1.6	1.78
cf. *Centropomus* sp.	1	1	0.15	1.2	0.04	0.02
Mycteroperca cf. *xenarcha*	1	3	5.20	1.2	0.1	0.70
Serranidae	–	5	10.55	–	0.19	1.42
cf. Serranidae	–	3	2.8	–	0.1	0.38
Caranx hippos	1	2	0.65	1.2	0.07	0.09
Caranx cf. *hippos*	–	1	0.25	–	0.04	0.03
Caranx sp.	1	2	0.85	1.2	0.07	0.11
Vomer cf. *declivifrons*	2	2	1.0	2.3	0.07	0.13
Carangidae	–	1	0.15	–	0.04	0.02
Lutjanus sp.	3	10	3.25	3.5	0.4	0.44
cf. *Lutjanus* sp.	–	3	0.65	–	0.1	0.09
Anisotremus sp.	1	2	0.55	1.2	0.07	0.07
Haemulon sp.	1	1	0.15	1.2	0.04	0.02
Orthopristis sp.	6	25	2.9	7.0	0.93	0.39
cf. *Orthopristis* sp.	–	6	0.65	–	0.2	0.09
Pomadasyidae	–	36	9	–	1.3	1.21
cf. Pomadasyidae	19	33	4.55	22.1	1.2	0.61
Calamus cf. *b[illegible]chysomus*	5	10	11.88	5.8	0.4	1.60
Cynoscion sp.	2	3	0.7	2.3	0.1	0.09
Mugil cephalus	1	1	0.25	1.2	0.04	0.03
Mugil sp.	1	14	1.65	1.2	0.5	0.22
cf. *Mugil* sp.	–	1	0.2	–	0.04	0.03
Scombridae	1	1	0.3	1.2	0.04	0.04
cf. Scombridae	–	1	0.75	–	0.04	0.10
identifiable Osteichthyes	1	1	0.65	1.2	0.04	0.08
unid. Osteichthyes verts.	–	1216	216.25	–	45.12	29.17
misc.	–	1086	222.55	–	40.30	30.02
TOTAL Osteichthyes	84	2666	619.98	97.7	98.89	83.63
Cheloniidae	1	8	100	1.2	0.3	13.49
cf. Cheloniidae	–	1	3.15	–	0.04	0.42
TOTAL Reptilia	1	9	103.15	1.2	0.34	13.91

TABLE 8 - Continued

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
unid. Mammalia	1	2	6.5	1.2	0.07	0.88
TOTAL Mammalia	1	2	6.5	1.2	0.07	0.88
unid bone	-	18	11.75	-	0.67	1.58
TOTAL FOOD BONE	86	2695	741.38	100.1	99.97	100

TABLE 9
FAUNAL LIST
OGSE-62C

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Arius-like	8	64	75.90	9.1	9.95	8.37
Bagre panamensis	48	50	112.00	54.5	7.78	12.35
Bagre sp.	-	32	34.05	-	5.0	3.76
Ariidae	-	7	6.95	-	1.1	0.77
unid. Siluriformes	-	6	4.25	-	0.9	0.47
Centropomus sp.	1	1	1.15	1.14	0.16	0.13
Mycteroperca sp.	1	5	31.60	1.14	0.8	3.48
cf. *Mycteroperca* sp.	2	4	17.45	2.27	0.6	1.92
Serranidae	-	11	32.95	-	1.7	3.63
Caranx sp.	1	2	3.30	1.14	0.3	0.36
Carangidae	-	4	6.75	-	0.6	0.74
Pomadasyidae	12	15	14.80	13.6	2.3	1.63
cf. Pomadasyidae	10	11	14.00	11.4	1.7	1.54
Calamus brachysomus	3	7	20.70	3.4	1.09	2.28
unid. Osteichthyes verts.	-	75	198.85	-	11.66	21.93
misc.	-	180	227.05	-	28.0	25.04
TOTAL Osteichthyes	86	474	801.75	97.7	73.7	88.42
Cheloniidae	1	22	69.75	1.14	3.4	7.69
cf. Cheloniidae	-	5	3.25	-	0.8	0.36
TOTAL Reptilia	1	27	73.0	1.14	4.2	8.05
unid. Mammalia	1	1	1.55	1.14	0.16	0.17
TOTAL Mammalia	1	1	1.55	1.14	0.16	0.17
unid. bone	-	141	30.45	-	21.93	3.36
TOTAL FOOD BONE	88	643	906.75	99.98	99.99	100

TABLE 10
FAUNAL LIST
OGSE-174

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Arius-like	3	9	10.7	17.6	4.46	1.91
Bagre-panamensis	4	4	12.6	23.6	1.98	2.25
Bagre sp.	-	1	2.6	-	0.5	0.46
Ariidae	-	3	4.1	-	1.49	0.73
Centropomus sp.	1	1	3.8	5.88	0.5	0.68
Carangidae	1	1	2.9	5.88	0.5	0.52
Pomadasyidae	3	3	2.9	17.6	1.49	0.52
cf. Pomadasyidae	-	1	00.65	5.88	0.5	0.12
unid. Osteichthyes verts.	-	23	36.7	-	11.39	6.55
misc.	-	13	43.5	-	6.44	7.76
TOTAL Osteichthyes	13	59	120.45	76.47	29.25	21.50
Cheloniidae	1	6	18.3	5.88	2.97	3.27
cf. Cheloniidae	-	1	1.35	-	0.5	0.24
TOTAL Cheloniidae	1	7	19.65	5.88	3.47	3.51
Odocoileus virginianus	1	17	133.83	5.88	8.42	23.88
cf. Odocoileus sp.	-	11	5.6	-	0.5	1.00
Cervidae	2	33	113.9	11.76	16.34	20.33
cf. Cervidae	-	6	24.5	-	2.97	4.37
large Mammalia	-	48	107.85	-	23.76	19.25
unid. Mammalia	-	1	1.05	-	0.5	0.19
cf. Mammalia	-	9	6.1	-	4.46	1.09
TOTAL Mammalia	3	115	392.83	17.6	56.95	70.11
unid. bone	-	21	27.45	-	10.40	4.90
TOTAL FOOD BONE	17	202	560.38	99.95	100.07	100.02

TABLE 11
FAUNAL LIST
VALDIVIA

	MNI	No. Frag.	% MNI	% Frag.
Carcharhinidae	1	3	1.1	0.16
TOTAL Chondrichthyes	1	3	1.1	0.16
Arius-like	2	33	2.2	1.71
Bagre panamensis	56	60	62.9	3.11
Bagre sp.	-	21	-	1.09
Ariidae	-	3	-	0.16
cf. Ariidae	-	3	-	0.16
unid. Siluriformes	-	1	-	0.05
cf. Siluriformes	-	1	-	0.05
Centropomus sp.	10	51	11.2	2.64
cf. Centropomus sp.	-	3	-	0.16
cf. Mycteroperca sp.	2	3	2.2	0.16
Serranidae	-	6	-	0.31
cf. Serranidae	-	2	-	0.10
Caranx sp.	1	1	1.1	0.05
Carangidae	1	10	1.1	0.52
Lutjanus sp.	1	2	1.1	0.10
cf. Lutjanus sp.	-	11	-	0.05
Pomadasyidae	1	1	1.1	0.05
cf. Pomadasyidae	-	1	-	0.05
Calamus brachysomus	1	3	1.1	0.16
Labridae	1	1	1.1	0.05
Scombridae	1	4	1.1	0.21
cf. Scombridae	-	2	-	0.10
unid. Osteichthyes verts.	-	238	-	12.32
misc.	-	410	-	21.22
TOTAL Osteichthyes	76	861	85.4	44.57
cf. Emydidae	1	1	1.1	0.05
Cheloniidae	1	41	1.1	2.12
cf. Cheloniidae	-	3	-	0.16
TOTAL Reptilia	2	45	2.2	2.33
Tayassu cf. pecari	1	1	1.1	0.05
Tayassu sp.	-	4	-	0.21
Odocoileus sp.	7	212	7.9	10.97
cf. Odocoileus sp.	-	6	-	0.31
Mazama sp.	2	17	2.2	0.88
cf. Mazama sp.	-	2	-	0.10
Cervidae	-	49	-	2.54
cf. Cervidae	-	3	-	0.16
large Mammalia	-	323	-	16.72
small Mammalia	-	316	-	16.36
cf. Mammalia	-	2	-	0.10
TOTAL Mammalia	10	935	11.2	48.40

TABLE 11 - Continued

	MNI	No. Frag.	% MNI	% Frag.
unid. bone	-	88	-	4.55
TOTAL FOOD BCNE	89	1932	99.9	100.01
Homo sapiens	1	25		
cf. *Homo sapiens*	-	6		
TOTAL BONE	90	1963		

TABLE 12
FAUNAL LIST
LOMA ALTA, JII

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
cf. Carcharhinidae	1	1	0.3	0.78	0.04	0.01
Sphyrna sp.	1	2	0.4	0.78	0.09	0.01
cf. Sphyrna sp.	-	1	0.30	--	0.04	0.01
Dasyatidae	1	1	0.1	0.78	0.04	0.01
TOTAL Chondrichthyes	3	5	1.1	2.34	0.21	0.04
Batrachoididae	1	2	4.8	0.78	0.08	0.12
Strongylura stolzmanni	1	1	1.5	0.78	0.04	0.04
Arius-like	3	9	9.65	2.34	0.39	0.24
Bagre panamensis	64	87	163.95	50	3.83	4.04
Bagre sp.	-	1	1.55	-	0.04	0.04
cf. Bagre sp.	-	2	0.3	-	0.09	0.01
Ariidae	-	15	11.95	-	0.66	0.29
cf. Ariidae	-	3	4.8	-	0.13	0.12
Siluriformes	-	74	26.65	-	3.25	0.66
Caranx sp.	1	4	6.85	0.78	0.18	0.17
cf. Hemicaranx sp.	1	1	0.05	0.78	0.04	0.01
cf. Vomer sp.	1	1	0.05	0.78	0.04	0.01
cf. Carangidae	-	1	0.1	-	0.04	0.01
Lutjanus sp.	1	3	1.55	0.78	0.13	0.04
Micropogon sp.	1	1	0.45	0.78	0.04	0.01
Larimus sp.	1	2	1.15	0.78	0.09	0.03
cf. Cynoscion sp.	1	6	0.75	0.78	0.26	0.02
Sciaenidae	-	2	0.8	-	0.09	0.02
cf. Cirrhites	1	1	0.1	0.78	0.04	0.01
cf. Auxis sp.	1	1	0.2	0.78	0.04	0.01
Scombridae	1	90	67.2	0.78	3.95	1.67
Sphyraena barracuda	1	1	0.1	0.78	0.04	0.01
Mugil sp.	1	1	0.1	0.78	0.04	0.01
Tetraodontidae	2	2	1.9	1.56	0.09	0.05
unid. Osteichthyes verts.	-	277	131.65	-	12.15	3.25
misc.	-	250	91.05	-	10.97	2.25
TOTAL Osteichthyes	83	838	528.3	64.82	36.73	13.03
Bufonidae	1	6	0.7	0.78	0.26	0.02
Ranidae	1	1	0.3	0.78	0.04	0.01
cf. Ranidae	-	1	0.1	-	0.04	0.01
Anuran	-	3	0.3	-	0.13	0.01
TOATAL Amphibian	2	11	1.4	1.56	0.47	0.04
Bothrops sp.	1	1	0.2	0.78	0.04	0.01
Boa constrictor	1	13	5.8	0.78	0.57	0.14
unid. serpentes	-	1	0.2	-	0.04	0.01
Emyidae	2	7	14.1	1.56	0.31	0.35
cf. Emidae	-	64	116.2	-	2.81	2.87
TOTAL Reptilia	4	86	136.5	3.12	3.77	3.37

TABLE 12 - Continued

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Tinamidae	1	3	0.9	0.78	0.13	0.02
Anatidae	1	1	0.35	0.78	0.04	0.01
Falco peregrinus	1	2	3.85	0.78	0.09	0.09
Cracidae	1	1	1.2	0.78	0.04	0.03
cf. Cracidae	-	1	1.25	-	0.04	0.03
Laridae	1	2	1.1	0.78	0.09	0.03
Columbidae	2	2	0.2	1.56	0.09	0.01
unid. Passeriformes	1	1	0.15	0.78	0.04	0.01
unid. Aves	-	13	4.15	-	0.57	0.10
cf. Aves	-	2	0.45	-	0.09	0.01
TOTAL Aves	8	28	13.6	6.24	1.22	0.34
Didelphidae	3	13	22.1	2.34	0.57	0.55
Sylvilagus sp.	2	8	4.7	1.56	0.35	0.12
Sciurus sp.	1	2	1.1	0.78	0.09	0.03
Sciuridae	1	4	1.8	0.78	0.18	0.04
cf. Proechimys sp.	1	2	1.25	0.78	0.09	0.03
Dasyprocta aguti	1	1	1.3	0.78	0.04	0.03
cf. Dasyprocta sp.	-	1	0.9	-	0.04	0.02
small Rodentia	4	21	4.2	3.13	0.92	0.10
Dusicyon cf. sechurae	1	1	2.85	0.78	0.04	0.07
Canis familiaris	3	26	117.95	2.34	1.14	2.91
Canis sp.	-	2	1.95	-	0.08	0.05
Canidae (not dog)	1	9	50.3	0.78	0.39	1.24
Felis concolor	1	1	2.9	0.78	0.04	0.07
Tayassu sp.	2	11	45.95	1.56	0.48	1.13
Odocoileus sp.	4	52	291.10	3.13	2.28	7.18
Mazama sp.	3			2.34		
Cervidae	-	220	1525.55	-	9.65	37.63
cf. Cervidae	-	2	13.3	-	0.09	0.33
unid. Mammalia	-	910	1325.7	-	39.93	32.70
TOTAL Mammalia	28	1286	3361.7	21.86	56.40	84.23
unid. bone	-	25	11.3	-	1.10	0.28
TOTAL FOOD BONE	128	2279	4053.9	99.94	99.90	101.33
Homo sapiens	5	326				
cf. Homo sapiens	-	1				
TOTAL BONE	133	2606				

TABLE 13
FAUNAL LIST
LOMA ALTA, JIII

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Bagre panamensis	5	17	18.95	21.74	2.9	0.72
Ariidae	–	2	0.95	–	0.34	0.04
Siluriformes	–	2	1.85	–	0.34	0.07
Carangidae	1	1	3.15	4.35	0.17	0.12
unid. Osteichthyes verts.	–	2	5.6	–	0.34	0.21
TOTAL Osteichthyes	6	24	30.6	26.09	4.09	1.16
cf. Emyidae	1	24	70.75	4.35	4.10	2.69
TOTAL Reptilia	1	24	70.75	4.35	4.10	2.69
Buteo sp.	1	1	1.1	4.35	0.17	0.04
Accipitridae	1	1	0.55	4.35	0.17	0.02
unid. Aves	–	4	1.40	–	0.68	0.05
cf. Aves	–	5	2.85	–	0.85	0.11
TOTAL Aves	2	11	5.9	8.70	1.87	0.22
Dasypus sp.	1	6	1.3	4.35	1.02	0.05
Sylvilagus sp.	1	3	1.8	4.35	0.51	0.07
Dasyprocta sp.	1	3	1.15	4.35	0.85	0.04
small Rodentia	1	1	0.1	4.35	0.17	0.01
Canis cf. familiaris	1	2	7.75	4.35	0.34	0.29
Cervidae	7	194	1806.05	30.4	33.1	68.69
cf. Cervidae	–	21	18.75	–	3.58	0.71
Tayassu sp.	1	7	76.85	4.35	1.19	2.92
Tapirus sp.	1	1	25.4	4.35	0.17	0.97
cf. Tapirus sp.	–	1	12.05	–	0.17	0.46
unid. Mammalia	–	279	558.6	–	47.61	21.24
TOTAL Mammalia	14	520	2509.8	60.87	88.74	95.45
unid. bone	–	7	12.35	–	1.19	0.47
TOTAL FOOD BONE	23	586	2629.4	100.01	99.99	99.99
Homo sapiens	2	643				
cf. Homo sapiens	–	c.500				
TOTAL BONE	25	c.1729				

TABLE 14
FAUNAL LIST
REAL ALTO, STRUCTURE 7

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Orectolobidae	1	2	0.65	0.75	0.05	0.03
Carcharhinidae	1	27	10.35	0.75	0.66	0.43
Rajiformes	1	3	0.6	0.75	0.07	0.02
TOTAL Chondrichthyes	3	32	11.6	2.25	0.78	0.48
Arius-like	18	274	94.9	13.5	6.7	3.93
Bagre panamensis	54	80	67	40.6	1.95	2.77
Bagre sp.	-	87	34.4	-	2.12	1.42
Ariidae	-	47	15.55	-	1.15	0.64
Siluriformes	-	27	7.85	-	0.66	0.33
Batracoididae	1	4	2.0	0.75	0.1	0.08
Centropomus sp.	2	5	1.15	1.5	0.12	0.05
Caranx hippos	1	1	0.55	0.75	0.02	0.02
Caranx sp.	4	8	2.95	3.0	0.2	0.12
cf. *Selene* sp.	1	1	0.2	0.75	0.02	0.01
Carangidae	1	1	0.15	0.75	0.02	0.01
cf. Carangidae	-	2	0.65	-	0.05	0.03
Lutjanus sp.	5	21	17.05	3.8	0.51	0.7
cf. *Lutjanus* sp.	-	3	0.4	-	0.07	0.1
Pomadasyidae	13	48	14.85	9.8	1.17	0.6
cf. Pomadasyidae	4	24	2.8	3.0	0.58	0.12
Bairdiella sp.	1	1	0.1	0.75	0.02	0.01
Cynoscion sp.	2	4	2.25	1.5	0.10	0.09
cf. *Cynoscion* sp.	-	6	1.45	-	0.15	0.06
Larimus sp.	10	19	12.3	7.5	0.46	0.51
Micropogon sp.	1	1	0.75	0.75	0.02	0.03
Paralonchurus sp.	1	3	1.10	0.75	0.07	0.05
Kyphosidae	1	1	0.1	0.75	0.02	0.01
Labridae	1	1	5.0	0.75	0.02	0.21
Mugil sp.	1	10	1.1	0.75	0.24	0.05
cf. *Mugil* sp.	-	1	0.1	-	0.02	0.01
unid. fish verts.	-	601	109.5	-	14.65	4.5
misc.	-	837	212.1	-	20.41	8.78
TOTAL Osteichthyes	122	2118	608.3	91.7	51.62	25.21
Cheloniidae	1	40	100.8	0.75	0.98	4.17
TOTAL Reptilia	1	40	100.8	0.75	0.98	4.17
unid. Aves	1	1	0.1	0.75	0.02	0.01
TOTAL Aves	1	1	0.1	0.75	0.02	0.01
cf. *Mazama* sp.	1	1	5.2	0.75	0.02	0.22
Odocoileus sp.	1	1	7.8	0.75	0.02	0.32
Cervidae	4	119	396.3	3.0	2.9	16.41
cf. Cervidae	-	1	8.6	-	0.02	0.36

TABLE 14 - Continued

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
unid Mammalia	-	1699	1207.05	-	41.43	49.98
TOTAL Mammalia	6	1821	1624.95	4.5	44.40	67.28
unid. bone	-	89	69.3	-	2.17	2.87
TOTAL FOOD BONE	133	4101	2415.05	99.95	99.97	100.02
Homo sapiens	1	12	100.45			
cf. *Homo sapiens*	-	6	25.75			
TOTAL BONE	134	4119	2541.25			

TABLE 15
FAUNAL LIST
REAL ALTO, STRUCTURE 10

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Carcharhinidae	1	6	0.95	3.2	1.0	0.38
unid. Chondrichthyes	-	1	0.5	-	0.17	0.20
TOTAL Chondrichthyes	1	7	1.45	3.2	1.17	0.58
Arius-like	1	12	2.7	3.2	2.01	1.08
Bagre panamensis	16	27	11.75	51.6	4.53	4.71
Bagre sp.	-	13	2.8	-	2.18	1.12
Ariidae	-	55	1.2	-	0.84	0.48
Lutjanus sp.	1	1	0.15	3.2	0.17	0.06
Pomadasyidae	1	2	0.35	3.2	0.34	0.14
cf. Pomadasyidae	2	3	0.90	6.5	0.5	0.36
Larimus sp.	3	3	1.6	9.7	0.5	0.64
cf. Larimus sp.	-	1	0.1	-	0.17	0.04
Paralonchurus sp.	1	1	0.05	3.2	0.17	0.02
Sciaendiae	-	1	0.1	-	0.17	0.04
Mugil sp.	1	1	0.1	3.2	0.17	0.04
unid. Osteichthyes verts.	-	74	11.55	-	12.42	4.63
misc.	-	189	18.5	-	31.71	7.41
TOTAL Osteichthyes	26	333	51.85	83.8	55.87	20.77
unid. Serpentes	1	1	0.15	3.2	0.17	0.06
TOTAL Reptilia	1	1	0.15	3.2	0.17	0.06
Anatidae	1	1	0.2	3.2	0.17	0.08
TOTAL Aves	1	1	0.2	3.2	0.17	0.08
Cervidae	1	17	60.4	3.2	2.85	24.2
cf. Canadáe	1	1	0.5	3.2	0.17	0.20
unid. Mammalia	-	233	131.45	-	39.09	52.7
TOTAL Mammalia	2	251	192.35	6.4	42.11	77.1
unid. bone	-	3	3.5	-	0.50	1.40
TOTAL FOOD BONE	31	596	249.5	99.8	99.99	99.99
Homo sapiens	1	1	0.45			
cf. Homo sapiens	-	1	1.3			
TOTAL BONE	32	598	251.25			

TABLE 16
FAUNAL LIST
REAL ALTO, FEATURE 10

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Orectolobidae	1	1	0.45	4.17	0.18	0.09
Carcharhinidae	1	5	2.65	4.17	0.90	0.51
TOTAL Chondrichthyes	2	6	3.10	8.3	1.08	0.60
Arius-like	2	46	14.4	8.3	8.3	2.79
Bagre paramensis	12	16	11.6	50	2.9	2.25
Bagre	-	8	5.1	-	1.4	0.99
Ariidae	-	5	1.65	-	0.9	0.32
Siluriformes	-	2	0.25	-	0.4	0.05
Centropomus sp.	1	1	0.2	4.17	0.18	0.04
Lutjanus sp.	1	1	0.6	4.17	0.18	0.12
Pomadasyidae	1	2	0.25	4.17	0.36	0.05
cf. Pomadasyidae	-	1	0.1	-	0.18	0.02
Micropogon sp.	1	1	0.35	4.17	0.18	0.07
unid. Osteichthyes verts.	-	36	9.2	-	6.47	1.78
misc.	-	47	13.9	-	8.45	2.69
TOTAL Osteichthyes	18	166	57.6	75	29.9	11.17
Cheloniidae	1	2	6.7	4.17	0.36	1.30
cf. Cheloniidae	-	1	3.0	-	0.18	0.58
TOTAL Reptilia	1	3	9.7	4.17	0.54	1.88
Anatidae	1	1	0.3	4.17	0.18	0.06
unid. Aves	-	2	0.4	-	0.36	0.08
TOTAL Aves	1	3	0.70	4.17	0.54	0.14
Cervidae	2	43	118.80	8.3	7.73	23.00
unid. Mammalia	-	330	324.5	-	59.35	62.83
TOTAL Mammalia	2	373	443.3	8.3	67.08	85.83
unid. bone	-	5	2.1	-	0.90	0.41
TOTAL FOOD BONE	24	556	516.5	99.94	100.04	100.03

TABLE 17
FAUNAL LIST
REAL ALTO, FEATURE 171

	MNI	No. Frag.	Bone Wt.	% MN1	% Frag.	% Bone Wt.
Orectolobridae	1	1	0.15	2.08	0.08	0.06
Carcharhinidae	1	16	3.3	2.08	1.34	1.24
Rajiformes	1	1	0.25	2.08	0.08	0.09
TOTAL Chondrichthyes	3	18	3.7	6.24	1.50	1.39
Arius-like	3	77	15.9	6.24	6.46	5.98
Bagre panamensis	10	10	4.8	2.08	0.84	1.80
Bagre sp.	-	19	3.1	-	1.59	1.17
Ariidae	-	23	4.9	-	1.93	1.84
Siluriformes	-	14	4.75	-	1.17	1.79
Batracoididae	1	3	0.6	2.08	0.25	0.23
Caranx sp.	1	1	0.3	2.07	0.08	0.11
cf. Selene sp.	2	2	0.3	4.17	0.17	0.11
Lutjanus sp.	1	3	0.45	2.08	0.25	0.17
Pomadasyidae	4	20	2.9	8.3	1.68	1.09
cf. Pomadasyidae	-	2	0.2	-	0.17	0.08
Bairdiella sp.	2	3	0.5	4.17	0.25	0.19
Cynoscion sp.	3	5	2.1	6.24	0.42	0.79
cf. Cynoscion sp.	1	2	0.35	2.08	0.17	0.13
Larimus sp.	13	20	8.9	27.1	1.68	3.35
Mugil sp.	1	7	0.75	2.08	0.59	0.28
Eleotridae	1	2	0.25	2.08	0.17	0.09
unid. Osteichthyes verts.	-	261	25.55	-	21.9	9.61
misc.	-	373	52.85	-	31.29	19.87
TOTAL Osteichthyes	43	847	129.45	89.5	71.07	48.68
Cheloniidae	1	1	0.6	2.08	0.08	0.22
TOTAL Reptilia	1	1	0.6	2.08	0.08	0.22
Cervidae	1	12	13.85	2.08	1.01	5.21
unid. Mammalia	-	311	114.9	-	26.1	43.2
TOTAL Mammalia	1	323	128.75	2.08	27.11	48.41
unid. bone	-	3	3.45	-	0.25	1.3
TOTAL FOOD BONE	48	1192	265.95	99.9	100.01	100.00
Homo sapiens	1	5	2.3			
TOTAL BONE	49	1197	260.25			

TABLE 18
FAUNAL LIST
REAL ALTO, BURIAL LI

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Carcharhinidae	1	5	0.6	2.9	0.7	0.2
TOTAL Chondrichthyes	1	5	0.6	2.9	0.7	0.2
Arius-like	7	56	24.0	20	8.0	8.7
Bagre panamensis	8	16	9.4	22.9	2.3	3.4
Bagre sp.	-	10	3.75	-	1.4	1.4
Ariidae	-	18	3.6	-	2.6	1.3
Siluriformes	-	6	2.5	-	0.9	0.9
Batracoididae	1	1	1.0	2.9	0.1	0.36
Centropomus sp.						
cf. Serranidae	1	1	0.15	2.9	0.1	0.05
cf. *Caranx* sp.	1	11	0.3	2.9	0.1	0.11
Lutjanus sp.	2	3	0.9	5.7	0.4	0.33
cf. *Lutjanus* sp.	-	1	0.15	-	0.1	0.05
Pomadasyidae	2	7	1.05	5.7	1.0	0.38
cf. Pomadasyidae	1	2	0.2	2.9	0.3	0.07
Cynoscion sp.	1	1	0.6	2.9	0.1	0.22
cf. *Cynoscion* sp.	1	2	0.65	2.9	0.3	0.23
Larimus sp.	3	6	3.35	8.6	0.9	1.21
cf. *Larimus* sp.	1	1	0.3	2.9	0.1	0.11
Micropogon sp.	1	1	0.2	2.9	0.1	0.07
Mugil sp.	1	3	0.7	2.9	0.4	0.25
unid. Osteichthyes verts.	-	106	15.65	-	15.2	5.64
misc.	-	188	35.3	-	26.9	12.73
TOTAL Osteichthyes	32	433	104.45	91.4	61.8	37.65
unid. Aves	1	1	0.15	2.9	0.1	0.77
TOTAL Aves	1	1	0.15	2.9	0.1	0.77
Cervidae	1	12	22.25	2.9	1.7	8.02
unid. Mammalia	-	245	146.65	-	35.1	52.87
TOTAL Mammalia	1	257	168.9	2.9	36.8	60.89
unid. bone	-	2	3.3	-	0.3	1.19
TOTAL FOOD BONE	35	698	277.4	100.1	99.7	100.7

TABLE 19
FAUNAL LIST
REAL ALTO, STRUCTURE 8 -- WALL TRENCH

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Orectolobidae	1	2	0.5	0.86	0.05	0.04
Carcharhinidae	1	16	2.8	0.86	0.63	0.2
TOTAL Chondrichthyes	2	18	3.3	1.72	0.71	0.24
Arius-like	29	182	65.25	25	7.14	4.65
Bagre panamensis	67	80	56.35	57.76	3.14	4.02
Bagre sp.	-	71	20.55	-	2.79	1.47
Ariidae	-	33	9.65	-	1.3	0.69
Siluriformes	-	7	1.2	-	0.27	0.09
Batrachoididae	1	1	0.25	0.86	0.04	0.02
Centropomus sp.	1	1	2.5	0.86	0.04	0.18
cf. Serranidae	1	2	1.7	0.86	0.08	0.12
cf. Carangidae	1	1	0.5	0.86	0.04	0.04
Pomadasyidae	1	2	0.3	0.86	0.08	0.02
cf. Pomadasyidae	5	7	0.8	4.31	0.27	0.06
cf. Cynoscion sp.	1	1	0.1	0.86	0.04	0.01
Paralonchurus sp.	1	11	0.2	0.86	0.04	0.01
Mugil sp.	1	3	0.5	0.86	0.12	0.04
unid. Osteichthyes verts.	-	112	21.0	-	4.4	1.50
misc.	-	143	34.35	-	5.6	2.45
TOTAL Osteichthyes	109	647	215.2	93.97	25.39	15.35
Cheloniidae	1	5	10.2	0.86	0.2	0.73
TOTAL Reptilia	1	5	10.2	0.86	0.2	0.73
cf. Aves	1	1	0.15	0.86	0.04	0.01
TOTAL Aves	1	1	0.15	0.86	0.04	0.01
Odocoileus sp.	1	12	73.6	0.86	0.47	5.25
cf. Mazama sp.	1	3	17.1	0.86	0.12	1.22
Cervidae	-	154	245.75	-	6.0	17.53
cf. Cervidae	-	1	0.3	-	0.04	0.02
unid. large Mammalia	-	1386	731.9	-	54.4	52.2
medium size Mammalia	1	2	0.6	0.86	0.08	0.04
TOTAL Mammalia	3	1558	1069.25	2.59	61.15	76.26
unid. bone	-	319	104.05	-	12.52	7.42
TOTAL FOOD BONE	116	2548	1402.15	100	100.01	100.01

TABLE 20
FAUNAL LIST
REAL ALTO, FEATURE 101

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Orectolobidae	1	1	0.1	1.75	0.07	0.01
Carcharhinidae	1	6	1.05	1.75	0.42	0.13
unid. Chondrichthyes	-	1	0.2	-	0.07	0.02
TOTAL Chondrichthyes	2	8	1.35	3.50	0.56	0.16
Arius-like	14	146	45.6	24.6	10.2	5.72
Bagre panamensis	26	26	18.8	45.6	1.8	2.36
Bagre sp.	-	30	13.5	-	2.1	1.69
Ariidae	-	22	4.5	-	1.5	0.56
Lutjanus sp.	1	2	0.85	1.75	0.1	0.11
cf. *Lutjanus* sp.	-	1	0.4	-	0.07	0.05
Pomadasyidae	5	8	1.1	8.8	0.56	0.14
cf. Pomadasyidae	3	9	0.8	5.3	0.61	0.10
Cynoscion sp.	1	1	0.3	1.75	0.07	0.04
Eleotridae	1	1	0.20	1.75	10.07	0.03
unid. Osteichthyes verts.	-	159	17.1	-	11.1	2.14
misc.	-	348	45.05	-	24.3	5.65
TOTAL Osteichthyes	51	753	148.2	89.47	52.58	18.59
Cheloniidae	1	10	18.9	1.75	0.7	2.37
TOTAL Reptilia	1	10	18.9	1.75	0.7	2.37
Cervidae	3	65	231.1	5.3	4.54	28.98
unid. Mammalia	-	587	392.9	-	40.99	49.27
TOTAL Mammalia	3	652	624.0	5.3	45.53	78.25
unid. bone	-	9	5.0	-	0.63	0.63
TOTAL FOOD BONE	57	1432	797.45	100.02	100	100

TABLE 21
FAUNAL LIST
REAL ALTO, FEATURE 108

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Orectolobidae	1	1	0.05	0.78	0.03	0.01
Carcharhinidae	1	17	4.15	0.78	0.46	0.16
Rajiformes	1	3	0.4	0.78	0.08	0.02
TOTAL Chondrichthyes	3	21	4.60	2.34	0.57	0.19
Arius-like	57	654	251.95	44.5	17.68	10.01
Bagre panamensis	43	51	38.05	33.6	1.38	1.51
Bagre sp.	–	75	27.73	–	2.03	1.08
Ariidae	–	187	48.35	–	5.05	1.92
Myteroperca sp.	1	1	0.4	0.78	0.03	0.02
Caranx hippos	1	2	2.2	0.78	0.05	0.09
Caranx sp.	1	1	0.1	0.78	0.03	0.01
cf. Caranx sp.	–	1	0.2	–	0.03	0.01
Carangidae	–	2	0.3	–	0.05	0.01
Lutjanus sp.	1	2	0.5	0.78	0.05	0.02
cf. Lutjanus sp.	–	1	0.4	–	0.03	0.02
cf. Orthopristis sp.	1	1	0.15	0.78	0.03	0.01
Pomadasyidae	8	30	3.85	6.25	0.8	0.15
cf. Pomadasyidae	–	5	0.95	–	0.14	0.04
cf. Cynoscion sp.	1	2	0.25	0.78	0.05	0.01
Micropogon sp.	3	4	2.35	2.34	0.11	0.09
cf. Sciaenidae	1	3	1.75	0.78	0.08	0.07
Mugil sp.	1	9	1.0	0.78	0.24	0.04
cf. Mugil sp.	–	1	0.3	–	0.03	0.01
Eleotridae	1	10	2.15	0.78	0.27	0.09
unid. Osteichthyes verts.	–	196	49.75	–	5.3	1.98
misc.	–	752	170.6	–	20.32	6.78
TOTAL Osteichthyes	120	1990	602.85	93.75	53.78	23.94
Cheloniidae	1	5	100.7	0.78	0.14	4.0
cf. Cheloniidae	–	4	13.6	–	0.11	0.54
TOTAL Reptilia	1	9	114.3	0.78	0.24	4.54
Anatidae	1	4	1.20	0.78	0.11	0.05
cf. Aves	–	1	0.1	–	0.03	0.01
unid. Aves	–	5	0.9	–	0.14	0.04
TOTAL Aves	1	10	2.2	0.78	0.27	0.09
Odocoileus sp.	3	7	87.85	2.34	0.19	3.49
Cervidae	–	172	557.45	–	4.65	22.14
unid. Mammalia	–	1328	1064.05	–	35.89	42.26
TOTAL Mammalia	3	1507	1709.35	2.34	40.73	67.89
unid. bone	–	163	84.7	–	4.4	3.36
TOTAL FOOD BONE	128	3700	2518	99.99	99.99	100.01
cf. Homo sapiens	1	1	1.7			

TABLE 22
FAUNAL LIST
REAL ALTO, FEATURE 109

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Dasyatidae	1	2	0.6	7.7	0.4	0.43
TOTAL Chondrichthyes	1	2	0.6	7.7	0.4	0.43
Arius-like	3	58	13.0	23	11.8	9.36
Bagre panamensis	4	5	1.45	30.8	1.0	1.04
Bagre sp.	-	9	3.3	-	1.8	2.37
Ariidae	-	17	3.6	-	3.5	2.6
Siluriformes	-	1	0.1	-	0.2	0.07
Lutjanus sp.	1	1	0.5	7.7	0.2	0.36
Pomadasyidae	1	3	0.35	7.7	0.6	0.25
cf. Pomadasyidae	1	2	0.2	7.7	0.4	0.14
Mugil sp.	1	2	0.4	7.7	0.4	0.29
unid. Osteichthyes verts.	-	110	13.3	-	22.4	9.57
misc.	-	56	6.55	-	11.4	4.71
TOTAL Osteichthyes	11	264	42.75	84.6	53.77	30.77
Odocoileus sp.	1	1	8.2	7.7	0.2	5.90
Cervidae	-	3	15.9	-	0.6	11.44
unid. Mammalia	-	218	70.9	-	44.4	51.03
TOTAL Mammalia	1	222	95.0	7.7	45.2	68.37
unid. bone	-	3	0.6	-	0.6	0.43
TOTAL FOOD BONE	13	491	138.95	100	99.97	100
Homo sapiens	1	8	36.5			

TABLE 23
FAUNAL LIST
REAL ALTO, NON-FEATURE MATERIAL

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Carcharhinidae	1	16	3.9	1.59	1.00	0.45
TOTAL Chondrichthyes	1	16	3.9	1.59	1.00	0.45
Arius-like	24	247	71.3	38.1	15.5	8.22
Bagre panamensis	29	31	22.85	46	1.95	2.64
Bagre sp.	–	66	20.75	–	4.1	2.39
Ariidae	–	25	4.2	–	1.57	0.48
Siluriformes (freshwater catfish)	1	1	0.1	1.59	0.06	0.01
Siluriformes	–	1	0.1	–	0.06	0.01
Serranidae	1	1	2.7	1.59	0.06	0.31
cf. Pomadasyidae	2	2	0.35	3.2	0.13	0.04
Mugil sp.	1	1	0.1	1.59	0.06	0.01
cf. Labridae	1	1	0.35	1.59	0.06	0.04
unid. Osteichthyes verts.	–	36	5.55	–	2.26	0.64
misc.	–	76	18.8	–	4.77	2.17
TOTAL Osteichthyes	59	488	147.15	93.65	30.65	17.1
Cheloniidae	1	3	1.9	1.59	0.2	0.22
cf. Cheloniidae	–	1	2.8	–	0.06	0.32
TOTAL Reptilia	1	4	4.7	1.59	0.26	0.54
Odocoileus sp.	1	1	12.5	1.59	0.06	1.44
Cervidae	1	64	119.35	1.59	4.0	13.77
unid. Mammalia	–	1012	574.7	–	63.57	66.29
TOTAL Mammalia	2	1077	706.55	3.2	67.65	81.5
unid. bone	–	7	4.60	–	0.44	0.53
TOTAL FOOD BONE	63	1592	866.9	100.03	101	100.12

TABLE 24
FAUNAL LIST
OGSE-46D, MACHALILLA

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Bagre panamensis	3	4	5.15	18.7	1.19	1.01
Bagre sp.	-	1	0.6	-	0.3	0.12
Ariidae	4	20	10.1	25	5.97	2.0
unid. Siluriformes	-	2	0.8	-	0.6	0.16
Batrachoididae	1	1	0.4	6.3	0.3	0.08
Serranidae	1	1	0.8	6.3	0.3	0.16
Labridae	1	1	0.9	6.3	0.3	0.18
Scombridae	1	5	1.0	6.3	1.49	0.20
idintifiable Osteichthyes	1	1	0.4	6.3	0.3	0.08
unid. Osteichthyes verts.	-	57	23.35	-	17.01	4.57
misc.	-	17	11.75	-	5.07	2.3
TOTAL Osteichthyes	12	110	55.25	75	32.83	10.81
Cheloniidae	1	184	421.4	6.3	54.92	82.39
cf. Cheloniidae	-	3	3.1	-	0.9	0.60
TOTAL Reptilia	1	187	424.5	6.3	55.82	82.99
Dasyprocta sp.	1	1	0.4	6.3	0.3	0.08
Canis sp.	1	1	0.6	6.3	0.3	0.12
cf. *Odocoileus virginianus*	1	2	3.0	6.3	0.6	0.59
TOTAL Mammalia	3	4	4.0	18.8	1.19	0.78
unid. bone	-	34	27.75	-	10.15	5.43
TOTAL FOOD BONE	16	335	511.5	100.1	99.99	100.01
Homo sapiens	1	13	4.6			
cf. *Homo sapiens*	-	18	0.35			
TOTAL BONE	17	366	516.45			

TABLE 25
FAUNAL LIST
OGSE-46D, ENGOROY

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Anguilliformes	1	1	0.15	4.76	0.09	0.03
Arius-like	2	5	2.6	9.5	0.5	0.46
Ariidae	–	28	9.8	–	2.6	1.72
unid. Siluriformes	–	8	3.55	–	0.7	0.62
cf. Centropomus sp.	1	1	0.25	4.76	0.09	0.04
Serranidae	1	1	0.4	4.76	0.09	0.07
cf. Serranidae	–	1	0.2	–	0.09	0.03
Haemulon cf. scudderii	1	1	0.3	4.76	0.09	0.05
Pomadasyidae	–	1	0.2	–	0.09	0.03
Calamus cf. brachysomus	2	5	4.4	9.5	0.5	0.77
cf. Calamus sp.	–	1	0.6	–	0.09	0.11
Cirrhitidae	1	1	1.9	4.76	0.09	0.33
Scombridae	3	91	31.95	14.29	8.35	5.59
Balistidae	1	1	1.2	4.76	0.09	0.21
Tetraodontidae	1	1	1.9	4.76	0.09	0.33
identifiable Osteichthyes	2	3	2.25	9.5	0.28	0.39
unid. Osteichthyes verts.	–	474	170.75	–	43.49	29.9
misc.	–	296	162.0	–	27.16	28.37
TOTAL Osteichthyes	16	920	394.4	76.19	84.4	69.07
Cheloniidae	1	75	106.5	4.76	6.88	18.65
cf. Cheloniidae	–	8	10	–	0.73	1.75
TOTAL Reptilia	1	83	116.5	4.76	7.61	20.4
Pelecanus occidentalis	1	1	0.85	4.76	0.09	0.15
cf. Aves	–	1	0.75	–	0.09	0.13
TOTAL Aves	1	2	1.60	4.76	0.18	0.28
Canis familiaris	1	1	2.2	4.76	0.09	0.39
Dysicyon cf. sechurae	1	1	2.1	4.76	0.09	0.38
Cervidae	1	1	9.05	4.76	0.09	1.58
unid. Mammalis	–	1	3.35	–	0.09	0.59
cf. Mammalia	–	1	1.6	–	0.09	0.28
TOTAL Mammalia	3	5	18.3	14.26	0.5	3.22
unid. bone	–	80	40.25	–	7.34	7.05
TOTAL FOOD BONE	21	1090	571.05	99.97	100.03	100.02

TABLE 26
FAUNAL LIST
OGSE-46D, TOTAL

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Anguilliformes	1	1	0.15	2.1	0.04	0.006
Arius-like	10	63	29.8	20.1	2.3	1.296
Bagre panamensis	5	8	9.9	10.4	0.29	0.43
Bagre cf. *panamensis*	–	1	0.3	–	0.04	0.013
Bagre sp.	–	8	8.1	–	0.29	0.352
Ariidae	–	74	48.33	–	2.7	2.102
unid. Siluriformes	–	22	9.4	–	0.8	0.4088
Batrachoididae	1	1	0.4	2.1	0.04	0.017
Centropomus sp.	1	1	0.25	2.1	0.04	0.011
cf. *Centropomus* sp.	1	1	0.25	2.1	0.04	0.011
Serranidae	1	3	2.0	2.1	0.11	0.087
cf. Serranidae	–	1	0.2	–	0.04	0.0087
Carangidae	1	2	1.9	2.1	0.07	0.0826
cf. Carangidae	–	1	1.15	–	0.04	0.05
Lutjanus sp.	1	3	1.45	2.1	0.11	0.063
cf. *Lutjanus* sp.	–	1	0.2	–	0.04	0.0087
Haemulon cf. *scudderii*	1	1	0.3	2.1	0.04	0.013
Pomadasyidae	–	1	0.2	–	0.04	0.0087
Calamus brachysomus	5	15	11.15	10.4	0.55	0.4848
cf. *Calamus* sp.	–	2	0.8	–	0.07	0.0348
Cynoscion sp.	1	1	1.2	2.1	0.04	0.052
Cirrhitidae	1	4	8.35	2.1	0.15	0.36
Labridae	1	2	1.25	2.1	0.07	0.054
Scombridae	4	153	53.35	8.3	5.60	2.320
Balistidae	2	2	3.65	4.2	0.07	0.159
cf. Balistidae	–	1	0.2	–	0.04	0.0087
Tetraodontidae	3	6	7.65	6.3	0.23	0.3327
unid. Osteichthyes verts.	–	823	301.8	–	30.12	13.124
misc.	–	540	340.35	–	19.77	14.8
TOTAL Osteichthyes	40	1742	844.03	83.3	63.76	36.70
Lepidochelys sp.	1	1	3.65	2.1	0.04	0.159
Cheloniidae	1	675	1257.4	2.1	24.71	54.68
cf. Cheloniidae	–	61	51.4	–	2.23	2.235
unid. Testudines	1	1	0.6	2.1	0.04	0.0261
TOTAL Reptilia	3	738	1313.05	6.3	27.01	57.10
Pelecanus occidentalis	1	1	0.85	2.1	0.04	0.037
cf. Aves	–	1	0.75	–	0.04	0.0326
TOTAL Aves	1	2	1.60	2.1	0.08	0.07
Dasyprocta sp.	1	1	0.4	2.1	0.04	0.017
Canis familiaris	1	1	2.2	2.1	0.04	0.096
Canis sp.	–	1	0.6	–	0.04	0.0261

TABLE 26 - Continued

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Dusicyon cf. sechurae	1	1	2.1	2.1	0.04	0.091
cf. Odocoileus sp.	1	3	12.05	2.1	0.11	0.524
large Mammalia	-	3	4.75	-	0.11	0.2066
unid. Mammalia	-	1	3.35	-	0.04	0.146
cf. Mammalia	-	2	2.9	-	0.07	0.126
TOTAL Mammalia	4	13	28.35	8.4	0.48	1.23
unid. bone	-	237	112.52	-	8.67	4.89
TOTAL FOOD BONE	48	2732	2299.55	100.1	99.99	99.99
Homo sapiens	1	3	4.6			
cf. Homo sapiens	-	18	0.35			
TOTAL BONE	49	2753	2304.5			

TABLE 27
FAUNAL LIST
OGCH-20

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Carcharhinidae	1	1	0.15	0.36	0.02	0.01
Chondrichthyes	-	1	0.6	-	0.02	0.01
TOTAL Chondrichthyes	1	2	0.75	0.36	0.04	0.02
Anguilliformes	1	3	0.65	0.36	0.05	0.02
Arius-like	93	791	263.65	33.1	12.8	6.88
Bagre panamensis	98	224	121.95	34.9	3.6	3.18
Bagre sp.	-	104	39.85	-	1.68	1.04
Siluriformes	-	95	29.00	-	1.54	0.76
Ariidae	-	155	46.70	-	2.5	1.22
Batracoididae	1	6	3.40	0.36	0.10	0.09
Centropomus sp.	1	1	0.5	0.36	0.02	0.01
Serranidae	3	4	1.5	1.07	0.06	0.04
Carangidae	1	2	1.0	0.36	0.03	0.03
Lutjanus sp.	1	4	1.6	0.36	0.06	0.04
Pomadasyidae	5	15	4.6	1.78	0.24	0.12
cf. Pomadasyidae	7	10	1.85	2.49	0.16	0.05
Calamus sp.	4	9	5.25	1.42	0.15	0.14
Cynoscion	2	3	1.10	0.71	0.05	0.03
Larimus sp.	23	51	30.7	8.18	0.82	0.80
cf. *Larimus* sp.	-	8	4.65	-	0.13	0.12
Micropogon sp.	13	19	10.0	4.63	0.31	0.26
cf. Sciaenops sp.	2	2	1.45	0.71	0.03	0.04
Sciaenidae	-	5	2.40	-	0.08	0.06
Labridae	2	6	2.60	0.71	0.10	0.07
cf. Labridae	-	1	0.35	-	0.02	0.01
Mugil sp.	1	12	2.45	0.36	0.19	0.06
Scombridae	1	20	3.65	0.36	0.32	0.10
Balistidae	2	5	7.25	0.71	0.08	0.19
Tetraodontidae	9	27	20.05	3.20	0.44	0.52
unid. Osteichthyes vert.	-	769	146.55	-	12.43	3.82
misc.	-	672	163.50	-	10.86	4.26
TOTAL Osteichthyes	270	3023	918.2	96.09	48.85	23.95
Cheloniidae	2	148	229.1	0.71	2.39	5.98
TOTAL Reptilia	2	148	229.1	0.71	2.39	5.98
cf. Aves	1	1	0.1	0.36	0.02	0.01
TOTAL Aves	1	1	0.1	0.36	0.02	0.01
Dusicyon sp.	2	16	15.4	0.71	0.26	0.4
Cervidae	5	265	893.17	1.78	4.28	23.30
medium size Mammalia	-	12	6.85	-	0.19	0.18
unid. Mammalia	-	2681	1745.75	-	43.33	45.53
TOTAL Mammalia	7	2974	2661.17	2.49	48.06	69.41

TABLE 27 - Continued

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
unid. bone	-	40	24.60	-	0.65	0.64
TOTAL FOOD BONE	281	6188	3833.92	100.01	100.01	100.01
Homo sapiens	1	2	0.80			
TOTAL BONE	282	6190	3834.72			

TABLE 28
FAUNAL LIST
OGSE-46U

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Carcharhinidae	1	15	15.4	1.5	1.4	3.5
TOTAL Chondrichthyes	1	15	15.4	1.5	1.4	3.5
Arius-like	30	312	152.5	46.2	29.7	35.1
Bagre panamensis	5	9	5.05	7.7	0.9	1.2
Ariidae	-	46	15.35	-	4.4	3.5
unid. Siluriformes	-	14	4.8	-	1.3	1.1
Batrachoididae	1	1	0.4	1.5	0.1	0.09
Epinephelus sp.	1	4	1.3	1.5	0.4	0.3
Serranidae	1	5	1.75	1.5	0.5	0.4
Caranx sp.	1	1	0.85	1.5	0.1	0.2
Lutjanus sp.	1	1	0.7	1.5	0.1	0.2
Haemulon sp.	2	2	0.6	3.0	0.2	0.1
cf. *Haemulon* sp.	1	1	0.15	1.5	0.1	0.03
cf. *Orthopristis* sp.	3	4	0.75	4.6	0.4	0.2
Pomadasyidae	-	6	3.7	-	0.6	0.8
cf. Pomadasyidae	-	3	1.7	-	0.3	0.40
Calamus cf. *brachysomus*	3	11	9.5	4.6	1.0	2.2
cf. *Calamus* sp.	-	1	0.3	-	0.1	0.07
Cynoscion sp.	3	3	0.5	4.6	0.3	0.1
cf. *Cynoscion* sp.	-	4	1.05	-	0.4	0.2
Labridae	1	22	1.5	1.5	0.2	0.3
Scombridae	2	10	3.7	3.0	0.9	0.8
Balistidae	1	2	0.65	1.5	0.2	0.1
Tetraodontidae	7	19	19.95	10.8	1.8	4.6
cf. Tetraodontidae	-	1	0.2	-	0.1	0.05
unid. Osteichthyes verts.	-	241	86.0	-	23.0	19.8
misc.	-	326	104.25	-	31.1	24.0
TOTAL Osteichthyes	63	1029	416.75	96.9	98.0	95.91
small Aves	1	1	0.05	1.5	0.1	0.01
cf. Aves	-	1	0.8	-	0.1	0.2
TOTAL Aves	1	2	0.85	1.5	0.2	0.21
unid. bone	-	3	1.7	-	0.3	0.4
TOTAL FOOD BONE	65	1049	434.7	99.9	99.9	100.02
Homo sapiens	1	1	9.6			
TOTAL BONE	66	1050	444.3			

TABLE 29
FAUNAL LIST
OGSE-41E

	MNI	No. Frag.	Bone Wt.	% MNI	% Frag.	% Bone Wt.
Rajiformes	1	1	0.9	8.3	1.54	1.63
TOTAL Chondrichthyes	1	1	0.9	8.3	1.54	1.63
Arius-like	1	1	0.9	8.3	1.54	1.63
Ariidae	-	2	1.1	-	3.08	2.00
Siluriformes	-	1	1.05	-	1.54	1.91
cf. *Centropomus* sp.	1	1	2.6	8.3	1.54	4.72
cf. Carangidae	1	6	7.6	8.3	9.23	13.79
Pomadasyidae	3	3	2.25	25	4.62	4.08
cf. Pomadasyidae	-	1	0.9	-	1.54	1.63
Calamus sp.	1	1	1.0	8.3	1.54	1.81
Scombridae	1	1	1.0	8.3	1.54	1.81
Sphyraena sp.	1	1	0.45	8.3	1.54	0.82
Labridae	1	1	0.9	8.3	1.54	1.63
unid. Osteichthyes verts.	-	11	7.75	-	16.92	14.07
misc.	-	24	15.1	-	36.92	27.40
TOTAL Osteichthyes	10	54	42.6	83.1	83.09	77.3
cf. Mammalia	1	1	1.25	8.3	1.54	1.81
TOTAL Mammalia	1	1	1.25	8.3	1.54	1.81
unid. bone	-	9	10.35	-	13.85	18.78
TOTAL FOOD BONE	12	65	55.1	99.7	100.02	99.52

APPENDIX B
TABLE 30
FOOD VALUES
OGSE-30

	Biomass in gram	Edible Meat in gram	Calories	Protein	% Biomass	% Edible Meat	% Calories	% Protein
Carcharhinidae	4639	4175	6513	730	5.3	5.44	6.10	4.44
Dasyatidae	2254	2029	1988	436	2.6	2.65	1.86	2.65
TOTAL Chondrichthyes	6893	6204	8501	1166	7.9	8.09	7.96	7.09
Bagre panamensis	1300	1014	1379	179	1.48	1.32	1.29	1.09
Arius-like	900	702	953	122	1.03	0.92	0.89	0.74
Centropomus sp.	3600	3312	3113	662	4.11	4.32	2.92	4.03
Serranidae	1475	1357	1181	262	1.68	1.77	1.11	1.59
Caranx sp.	4600	4232	6306	868	5.25	5.52	5.91	5.28
Lutjanus sp.	300	276	257	55	0.34	0.36	0.24	0.33
cf. *Lutjanus* sp.	1650	1518	1412	301	1.88	1.98	1.32	1.83
Cynoscion sp.	225	207	225	39	0.26	0.27	0.21	0.24
Micropogon sp.	900	828	795	147	1.03	1.08	0.74	0.89
Odontoscion sp.	400	368	361	68	0.46	0.48	0.34	0.41
cf. Sciaenidae	125	115	113	21	0.14	0.15	0.11	0.13
Mugil sp.	550	506	739	99	0.63	0.66	0.69	0.60
Scombridae	10900	10028	16546	2326	12.44	13.08	15.50	14.15
TOTAL Osteichthyes	26925	24463	33380	5149	30.73	31.91	31.37	31.31
Bufonidae	58	54	39	9	0.07	0.07	0.04	0.05
Anura	58	54	39	9	0.07	0.07	0.04	0.05
TOTAL Amphibia	116	108	78	18	0.14	0.14	0.08	0.10
Cheloniidae	49	29	26	6	0.06	0.04	0.02	0.04
Constrictor constrictor	584	531	-	-	0.67	0.69	-	-
Drymarchon corais	351	319	-	-	0.40	0.42	-	-
TOTAL Reptilia	984	879	26	6	1.13	1.15	0.02	0.04

TABLE 30 -- Continued

	Biomass in gram	Edible Meat in gram	Calo- ries	Pro- tein	% Bio- mass	% Edible Meat	% Calo- ries	% Pro- tein
Psittacidae	183	146	204	28	0.21	0.19	0.19	0.17
TOTAL Aves	183	146	204	28	0.21	0.19	0.19	0.17
Cricetinae	1232	986	1873	259	1.41	1.29	1.76	1.56
Sylvilagus cf. *brasiliensis*	1500	1260	1701	265	1.71	1.64	1.59	1.61
Mustela so.	350	273	519	72	0.40	0.36	0.49	0.44
Dusicyon cf. *sechural*	11834	9437	17930	2482	13.51	12.31	16.80	15.10
Canidae	2043	1634	3105	430	2.33	2.13	2.91	2.62
cf. *Mazama*	35535	31271	39401	6567	40.57	40.79	36.92	39.94
TOTAL Mammalia	52494	44861	64529	10075	59.93	58.52	60.47	61.27
TOTAL	87595	76661	106718	16442	100.04	100.00	100.09	99.98

TABLE 31
FOOD VALUE
OGSE-63

	Biomass in gram	Edible Meat in gram	Calo- ries	Pro- tein	% Bio- mass	% Edible Meat	% Calo- ries	% Pro- tein
Arius-like	230	243	243	32	0.17	0.15	0.16	0.13
Bagre panamensis	1525	1190	1618	209	1.12	1.00	1.08	0.84
Cynoscion sp.	3750	3450	3726	656	2.77	2.89	2.49	2.63
cf. _Micropogon_ sp.	675	621	609	115	0.50	0.52	0.41	0.46
Mugil sp.	350	322	470	63	0.26	0.27	0.31	0.25
TOTAL Osteichthyes	6530	5762	6666	1075	4.82	4.83	4.45	4.31
Cheloniidae	24	14	12	3	0.02	0.01	0.01	0.01
TOTAL Reptilia	24	14	12	3	0.02	0.01	0.01	0.01
Odocoileus virginianus	90866	79962	100752	16792	67.01	67.00	67.27	67.37
Mazama sp.	38189[illegible]	33601	42337	7056	28.16	28.20	28.27	28.31
TOTAL Mammalia	129055	113563	143089	23848	95.17	95.16	95.54	95.64
TOTAL	135609	119339	149767	24926	100.01	100.00	100.00	99.96

TABLE 32
FOOD VALUES
OGSE-62

	Biomass in gram	Edible Meat in gram	Calories	Protein	% Biomass	% Edible Meat	% Calories	% Protein
Albula vulpes	650	598	598	123	1.16	1.55	1.40	1.60
Arius-like	1700	1326	1803	233	3.05	3.43	4.23	3.04
Bagre panamensis	14500	1131	1538	199	25.97	2.93	3.61	2.60
Siluriformes (freshwater catfish)	500	390	530	69	0.90	1.01	1.24	0.90
cf. *Centropomus* sp.	475	437	411	87	0.85	1.13	0.96	1.13
Mycteroperca cf. *xenarcha*	5225	4807	4182	928	9.36	12.43	0.80	12.10
Caranx sp.	4300	2956	5894	811	7.70	10.23	13.82	10.58
Vomer cf. *declivifrons*	1675	1541	2296	316	3.00	3.99	5.35	4.12
Lutjanus sp.	2675	2461	2289	487	4.79	6.37	5.37	6.35
Anisotremus sp.	1375	1265	1265	259	2.46	3.27	2.97	3.38
Haemulon sp.	525	483	483	99	0.94	1.25	1.13	1.29
Orthopristis sp.	2075	1909	1909	391	3.72	4.94	4.48	5.10
cf. Pomadasyidae	12200	11224	11224	2301	21.85	29.03	26.31	30.01
Calamus cf. *brachysomus*	5875	5405	6054	1027	10.52	13.95	14.19	13.39
Cynoscion sp.	725	667	724	127	1.30	1.73	1.70	1.66
Mugil sp.	900	828	1209	162	1.61	2.14	2.83	2.11
TOTAL Osteichthyes	55375	38428	42409	7619	99.18	99.41	99.42	99.36
Cheloniidae	346	142	126	28	0.62	0.37	0.30	0.37
TOTAL Reptilia	346	142	126	28	0.62	0.37	0.30	0.37
unid. Mammalia	107	94	118	20	0.19	0.24	0.28	0.26
TOTAL Mammalia	107	94	118	20	0.19	0.24	0.28	0.26
TOTAL	55828	38664	42653	7667	99.99	100.02	100.00	99.99

TABLE 33
FOOD VALUE
OGSE-62C

	Biomass in gram	Edible Meat in gram	Calo-ries	Pro-tein	% Bio-mass	% Edible Meat	% Calo-ries	% Pro-tein
Arius-like	4350	3393	4614	597	6.88	6.25	7.37	5.79
Bagre panamensis	22925	17822	24320	3147	36.24	32.96	38.83	30.54
Centropomus sp.	1750	1610	1513	322	2.77	2.97	2.42	3.12
Mycteroperca sp.	13275	12213	10625	2357	20.99	22.51	16.96	22.87
cf. Mycteroperca sp.								
Caranx sp.	4600	4232	6306	868	7.27	7.80	10.07	8.42
Pomadasyidae	6900	6348	6348	1301	10.91	11.70	10.13	12.63
cf. Pomadasyidae	6000	5520	5520	1132	9.49	10.18	8.81	10.99
Calamus brachysomus	3175	2921	3272	554	5.02	5.33	5.22	5.38
TOTAL Osteichthyes	62975	54119	62518	10278	99.55	99.76	99.81	99.75
Cheloniidae	257	106	94	21	0.41	0.19	0.15	0.20
TOTAL Reptilia	257	106	94	21	0.41	0.19	0.15	0.20
Mammalia	25	22	28	5	0.04	0.04	0.04	0.04
TOTAL Mammalia	25	22	28	5	0.04	0.04	0.04	0.04
TOTAL	63257	54247	62640	10304	100.00	99.99	100.00	99.99

TABLE 34
FOOD VALUES
VALDIVIA

	Biomass in gram	Edible Meat in gram	Calo-ries	Pro-tein	% Bio-mass	% Edible Meat	% Calo-ries	% Pro-tein
Carcharhinidae	7618	6856	10695	1207	1.41	1.44	1.85	1.23
TOTAL Chondrichthyes	7618	6856	10695	1207	1.41	1.44	1.85	1.23
Arius-like	975	761	1035	134	0.18	0.16	0.18	0.14
Bagre panamensis	27900	21762	29596	3830	5.18	4.57	5.13	3.91
Centropomus sp.	93229	85767	80621	17153	17.30	18.02	13.98	17.49
cf. Mycteroperca sp.	9900	9108	7924	1758	1.84	1.91	1.37	1.79
Carangidae	8800	8096	12063	1660	1.63	1.70	2.09	1.69
Lutjanus sp.	971	893	830	177	0.18	0.19	0.14	0.18
Pomadasyidae	1150	1058	1058	217	0.21	0.22	0.18	0.22
Calamus brachysomus	850	782	952	149	0.16	0.16	0.17	0.15
Labridae	1700	1564	1564	321	0.32	0.33	0.27	0.32
Scombridae	4525	4163	6869	966	0.84	0.87	1.19	0.98
TOTAL Osteichthyes	149996	133954	142512	26365	27.84	28.13	24.70	26.87
cf. Emydidae	-	-	-	-	-	-	-	-
Cheloniidae	-	-	-	-	-	-	-	-
TOTAL Reptilia	-	-	-	-	-	-	-	-
Tayassu cf. pecari	2400	1800	3420	473	0.45	0.38	0.59	0.48
cf. Odocoileus sp.	316201	278257	350604	58434	58.67	58.45	60.79	59.58
cf. Mazama sp.	62736	55208	69562	11594	11.64	11.60	12.06	11.52
TOTAL Mammalia	381337	335265	423586	70501	70.76	70.43	73.44	71.88
TOTAL	538951	476075	576793	98073	100.01	100.00	99.99	99.98

TABLE 35
FOOD VALUE
OGSE-46D

	Biomass in gram	Edible Meat in gram	Calo-ries	Pro-tein	% Bio-mass	% Edible Meat	% Calo-ries	% Pro-tein
Anguilliformes	425	391	911	62	0.71	0.75	1.31	0.56
Arius-like	3925	3611	4911	636	6.55	6.89	7.06	5.79
Bagre panamensis	2150	1975	2690	348	3.59	3.78	3.87	3.17
Batracoididae	450	414	414	85	0.50	0.79	0.60	0.78
Centropomus sp.	2075	1909	1794	382	3.46	3.64	2.58	3.48
Serranidae	1475	1357	1181	262	2.46	2.59	1.70	2.38
Carangidae	2200	2024	3016	415	3.67	3.86	4.34	3.78
Lutjanus sp.	975	897	834	186	1.63	1.71	1.20	1.69
Haemulon cf. scudderii	1450	1334	1334	273	2.42	2.55	1.92	2.48
Calamus brachysomus	7075	6509	7290	1237	11.80	12.42	10.48	11.26
Cynoscion sp.	4825	4439	4794	843	8.05	8.47	6.89	7.67
Cirrhitidae	2075	1909	1909	391	3.46	3.64	2.74	3.56
Labridae	1355	1247	1247	256	2.26	2.38	1.80	2.33
Scombridae	10350	9522	15711	2209	17.27	18.18	22.59	20.10
Balistidae	3650	3358	3358	688	6.09	6.41	4.83	6.26
Tetraodontidae	2550	2346	2346	481	4.25	4.48	3.37	4.38
TOTAL Osteichthyes	47005	43245	53740	8754	78.47	82.54	77.28	79.67
Cheloniidae (Lepidochelys)	3019	1208	1075	239	5.04	2.31	1.55	2.18
unid. Testudines	4	2	2	0.4	0.01	0.01	0.01	0.01
TOTAL Reptilia	3023	1210	1077	239.4	5.05	2.32	1.56	2.19
Pelecanus occidentalis	1582	1266	1772	246	2.64	2.42	2.55	2.24
TOTAL Aves	1582	1266	1772	246	2.64	2.42	2.55	2.24
Dasyprocta sp.	5000	4000	7960	1052	8.34	7.64	11.44	9.57
Dusicyon cf. sechurae	3204	2563	4870	674	5.35	4.89	7.00	6.13

TABLE 35 - Continued

	Biomass in gram	Edible Meat in gram	Calories	Protein	% Biomass	% Edible Meat	% Calories	% Protein
Cervidae	120	106	134	22	0.20	0.20	0.19	0.20
TOTAL Mammalia	8324	6669	12964	1748	13.89	12.73	18.63	15.90
TOTAL	59934	52390	69553	10987.4	100.05	100.01	100.02	100.00

TABLE 36
FOOD VALUE
OGSE-46U

	Biomass in gram	Edible Meat in gram	Calo-ries	Pro-tein	% Bio-mass	% Edible Meat	% Calo-ries	% Pro-tein
Carcharhinidae	189335	170401	265826	29991	81.10	81.37	85.03	79.58
TOTAL Chondrichthyes	189335	170401	265826	29991	81.10	81.37	85.03	79.58
Arius-like	9757	7611	10350	1339	4.18	3.63	3.31	3.55
Bagre panamensis	1475	1151	1564	203	0.63	0.55	0.50	0.54
Batrachoididae	450	414	414	85	0.19	0.20	0.13	0.23
Epinephelus sp.	825	759	660	146	0.35	0.36	0.21	0.39
Serranidae	1475	1357	1181	262	0.63	0.65	0.38	0.70
Caranx hippos	3000	2760	4112	566	1.29	1.32	1.32	1.50
Lutjanus sp.	925	851	1268	174	0.40	0.41	0.40	0.46
Haemulon sp.	3750	3450	3450	707	1.61	1.65	1.10	1.88
cf. Orthopristis sp.	1425	1311	1311	269	0.61	0.63	0.42	0.71
Calamus brachysomus	4875	4485	5023	852	2.08	2.14	1.61	2.26
Cynoscion sp.	3675	3381	3651	642	1.57	1.61	1.17	1.70
Labridae	1350	1242	1242	255	0.58	0.59	0.40	0.68
Scombridae	3875	3565	5882	827	1.66	1.70	1.85	2.19
Balistidae	975	897	897	184	0.42	0.43	0.29	0.49
Tetraodontidae	6275	5773	5773	1183	2.69	2.76	1.85	3.14
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Unid. Aves	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL Aves	8	6	8	1	0.01	0.01	0.01	0.01
TOTAL	233450	209414	312612	37686	100.00	100.01	100.01	100.01

APPENDIX C
FORMULAE FOR ESTIMATING LIVE WEIGHT

sharks: sample size = 5

$\text{Log } y = 4.2183 (\log x) - 0.6197$
where y = live weight in grams
x = dorsal-ventral centrum diameter in mn.
4 = 0.9994

$\text{Log } y = 4.6686 (\log x) - 1.0817$
where y = live weight in grams
x = lateral centrum diameter in mn.
r = 0.9965

rays: proporation method used

catfish: sample size = 5

$\text{Log } y = 0.8248 (\log x) + 1.5470$
where y = live weight in grams
x = skeletal weight in grams
r = 0.9580

perciformes: sample = 6

$\text{Log } y = 2.7802 (\log x) + 0.6785$
where y = live weight in grams
x = anterior atlas centrum lateral diameter in mn.
r = 0.9908

$\text{Log } y = 2.2601 (\log x) + 0.9807$
where y = live weight in grams
x = centrum diameter for cervicals 2 thru 8 in mn.
r = 0.9834

$\text{Log } y = 0.7775 (\log x) + 1.6717$
where y = live weight in grams
x = skeletal weight in grams
r = 0.9543

other fishes - perciformes formulae used

amphibians - Anurans: proportion method used

turtles: sample size = 9

$$\log y = 0.851 (\log x) + 0.8229$$

where y = live weight in grams
x = skeletal weight in grams
r = 0.9424

snake: sample size = 7

$$\log y = 2.7160 (\log x) + 1.1018$$

where y = live weight in grams
x = centrum diameter in mn.
r = 0.8978

birds: sample size = 26

$$\log y = 0.8212 (\log x) + 1.2402$$

where y = live weight in grams
x = skeletal weight in grams
r = 0.9734

rabbit: used estimate of 1.5 kg.

agouti: used estimate of 5.0 kg

peccary: used estimate of 24 kg.

other mammals:

$$\log y = 1.0133 (\log x) + 1.2049$$

where y = live weight in grams
x = skeletal weight in grams
r = 0.9832

APPENDIX D
PERCENT EDIBLE MEAT

Shark	90%
Ray	90%
Catfish	78%
Other fishes	92%
Frog	93%
Turtle	60%
Snake	90%
Bird	80%
Rodent	80%
Rabbit	84%
Weasel	78%
Fox	80%
Peccary	50%
Deer	88%

APPENDIX E

Scientific Name	Food Values			
	Description	Cal./ 100 g.	Protein/ 100 g.	Reference
Carcharhinidae	raw	156	17.6	W. & M. (dogfish shark)
Dasyatidae	raw	98	21.5	W. & M. (skate)
Albula vulpes	raw	100	20.5	Leung (fish from the sea)
Anguilliformes	raw	233	15.9	W. & M. (Anguilla)
Siluriformes (in part)	raw	103	17.6	W. & M. (Ictalurus)
Arius-like	raw	136	17.6	Leung (Bagre)
Bagre sp.	raw	136	17.6	Leung (Bagre)
Batrachoididae	raw	100	20.5	Leung (fish from the sea)
Centropomus sp.	raw	94	20.0	Leung (Robalo)
Epinephelus sp.	raw	87	19.3	W. & M. (Grouper)
Mycteroperca sp.	raw	87	19.3	W. & M. (Grouper)
Serranidae	raw	87	19.3	W. & M. (Grouper)
Caranx sp.	raw	149	20.5	W. & M. (average of 3 jacks)
Vomer sp.	raw	149	20.5	W. & M. (average of 3 jacks)
Carangidae	raw	149	20.5	W. & M. (average of 3 jacks)
Lutjanus sp.	raw	93	19.8	W. & M. (Lutjanus)
Anisotremus sp.	raw	100	20.5	Leung (fish from the sea)
Haemulon sp.	raw	100	20.5	Leung (fish from the sea)
Orthopristis sp.	raw	100	20.5	Leung (fish from the sea)
Pomadasyidae	raw	100	20.5	Leung (fish from the sea)
Calamus sp.	raw	112	19	W. & M. (Calamus)
Cynoscion sp.	raw	108	19	W. & M. (ave. of 2 Cynoscion)
Micropogon sp.	raw	98	18.5	W. & M. (ave. of 6 Drums)
Odontoscion sp.	raw	98	18.5	W. & M. (ave. of 6 Drum)
Sciaenops sp.	raw	98	18.5	W. & M. (ave. of 6 Drum)
Sciaenidae	raw	98	18.5	W. & M. (ave. of 6 Drum)
Cirrhitidae	raw	100	20.5	Leung (fish from the sea)
Labridae	raw	100	20.5	Leung (fish from the sea)
Mugil sp.	raw	146	19.6	W. & M. (Mugil)
Scombridae	raw	164	23.2	W. & M. (ave. of 6 Scombridae)

Scientific Name	Description	Cal./ 100 g.	Protein/ 100 g.	Reference
Balistidae	raw	100	20.5	Leung (fish from the sea)
Tetraodontidae	raw	100	20.5	Leung (fish from the sea)
Bufonidae	raw	73	16.4	W. & M. (*Rana*)
Anuran	raw	73	16.4	W. & M. (*Rana*)
Emydidae	raw	111	18.6	W. & M. (*Malaclemys*)
Testudines	raw	111	18.6	W. & M. (*Malaclemys*)
Cheloniidae	raw	89	19.6	W. & M. (*Chelonia*)
Pelecanus sp.	raw	140	19.4	W. & M. (ave. of duck and pigeon)
Psittacidae	raw	140	19.4	W. & M. (ave. of duck and pigeon)
Aves	raw	140	19.4	W. & M. (ave. of duck and pigeon)
Sylvilagus sp.	raw	135	21	W. & M. (*Sylvilagus*)
Dasyprocta sp.	raw	190	26.3	W. & M. (ave. of 6 mammals*)
Cricetinae	raw	190	26.3	W. & M. (ave. of 6 mammals*)
Mustela sp.	raw	190	26.3	W. & M. (ave. of 6 mammals*)
Dusicyon sp.	raw	190	26.3	W. & M. (ave. of 6 mammals*)
Canidae	raw	190	26.3	W. & M. (ave. of 6 mammals*)
Tayassu sp.	raw	190	26.3	W. & M. (ave. of 6 mammals*)
Mazama sp.	raw	126	21	W. & M. (lean meat only *Odocoileus*)
Odocoileus sp.	raw	126	21	W. & M. (lean meat only *Odocoileus*)
Cervidae	raw	126	21	W. & M. (lean meat only *Odocoileus*)
Mammalia	raw	190	26.3	W. & M. (ave. of 6 mammals*)

W. & M. - Watt and Merrill 1975 (orig. 1963)

Leung - Leung (1961)

*These six mammals include beaver, muskrat, opossum, rabbit, raccoon and deer.

APPENDIX F

Scientific Name	Common Name
Orectolobidae	Carpet Sharks
Carcharhinidae	Requiem Sharks
Sphyrna sp.	Hammerhead Shark
Dasyatidae	Stingrays
Rajiformes	Skates and Rays
Chondrichthyes	Cartilaginous Fishes
Albula vulpes	Bonefish
Angilliformes	Eel
Clupeidae	Herring
Engraulidae	Anchovy
Siluriformes (in part)	Freshwater Catfish
Siluriformes	Catfish
Arius-like	Sea Catfish
Bagre panamensis	Chilhuil
Bagre	Sea Catfish
Ariidae	Sea Catfish
Batrachoididae	Toadfish
Exocoetidae	Halfbeak and Flyingfish
Strongylura stolzmanni	Needlefish
Centropomus	Snook
Epinephelus	Sea Bass, Grouper
Myteroperca	Grouper
Serranidae	Sea Basses, Groupers
Caranx	Jack
Caranx hippos	Crevalle Jack
Hemicaranx	Jack
Vomer	Moonfish, Jack
Selene	Lookdown, Jack
Carangidae	Jacks, Pompanos
Coryphaenidae	Dolphinfish
Lutjanus	Snappers
Gerreidae	Mojarras
Anisotremus	Grunts
Haemulon	Grunts
Orthopristis	Grunts
Pomadasyidae	Grunt
Calamus	Porgy
Bairdiella	Drum
Cynoscion	Seatrout, Drum
Larimus	Drum
Micropogon	Drum, Croaker

Odontoscion	Drum, Croaker
Paralonchurus	Drum
Sciaenidae	Drum
Kyphosidae	Sea Chub
Cirrhites	Hawkfish
Cirrhitidae	Hawkfish
Labridae	Wrass
Mugil	Mullet
Mugil cephalus	Striped Mullet
Sphyraena barracuda	Barracuda
Eleotridae	Sleeper
Gobiidae	Gobies
Scombridae	Mackerels and Tunas
Auxis	Mackerel
Balistidae	Triggerfish
Tetrodontidae	Puffers
Osteichthyes	Bony Fishes
Bufonidae	Toad
Ranidae	Frog
Anuran	Toads and Frogs
Amphibia	Amphibians
Emydidae	Box and Water Turtles
Lepidochelys	Sea Turtle
Cheloniidae	Sea Turtles
Constrictor constrictor	
Boa constrictor	
Drymarchon corais	Indigo Snake
Bothrops	
Serpentia	Snake
Reptilia	Reptile
[illegible]	[illegible]
Tinamidae	Tinamou
Pelecanus occidentalis	Brown Pelican
Anatidae	Duck
Buteo	
Accipitridae	Hawks
Falco peregrinus	Peregrine Falcon
Cracidae	Curassow
Laridae	Gull
Columbidae	Pigeon
Psittacidae	Parrot
Passeriformes	Song Birds
Aves	Birds
Didelphidae	Opossum
Homo sapiens	Man
Dasypus	Armadillo
Sylvilagus	Rabbit
Sciurus	Squirrel
Sciuridae	Squirrel
Proechimys	Spiny rat

Cricetinae	Rodents
Dasyprocta agouti	Agouti
Rodentia	Rodents
Mustelidae	Weasel
Dusicyon	Fox
Canis familiaris	Dog
Canidae	Dogs and Wolfs
Felis concolor	Mountain Lion
Tapirus	Tapir
Odocoileus	White-tailed Deer
Mazama	Brocket Deer
Cervidae	Deer
Tayassu	Peccary
Mammalia	Mammals

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BIOGRAPHICAL SKETCH

Kathleen Mary Byrd was born on February 2, 1949 in Stamford, Connecticut, the daughter of Mr. and Mrs. Daniel Byrd of New Canaan, Connecticut. The oldest of two children, she attended elementary and secondary schools in New Canaan and Stamford.

After two years at the College of St. Elizabeth in New Jersey, she transferred to Marquette University in Milwaukee, Wisconsin, where she majored in anthropology. Subsequent to her graduation from Marquette, in 1971 with a B.A. degree, she entered the graduate program at Louisiana State University in Baton Rouge, Louisiana. At this institution she continued her study of archaeology and developed an interest in zoo-archaeology and prehistoric subsistence patterns. She received her M.A. degree from that university in 1974. While still completing her thesis she transferred to the University of Florida to continue her study of anthropology and particularly archaeology and zooarchaeology. During the interim she made two archaeological field trips to South America, one to Argentina and the other to Ecuador. The latter trip resulted in her dissertation research. She is presently a candidate for the Doctor of Philosophy degree in anthropology at the University of Florida.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Associate Professor of Anthropology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William R. Maples
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August, 1976

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